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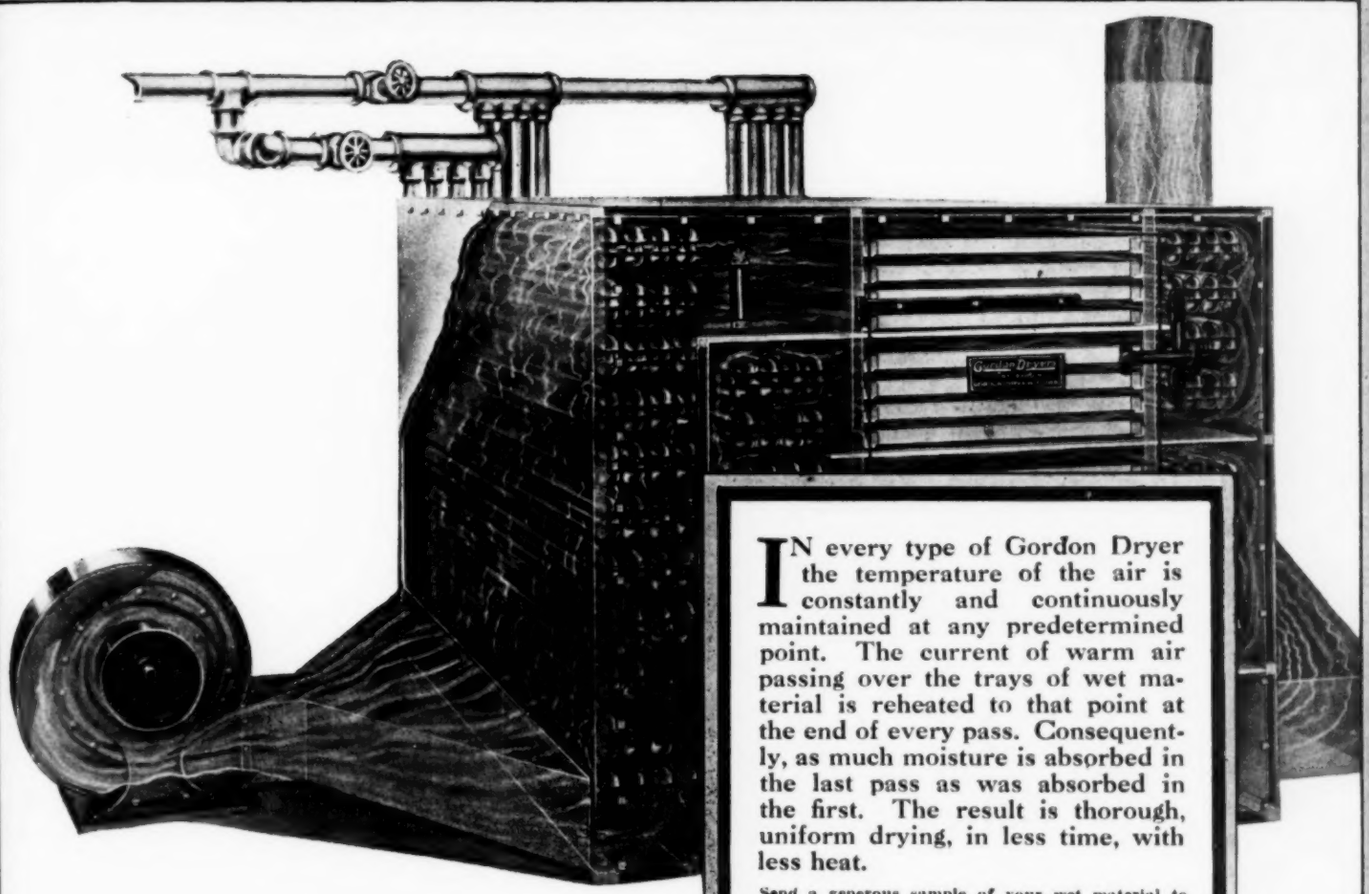
CHEMICAL & METALLURGICAL ENGINEERING



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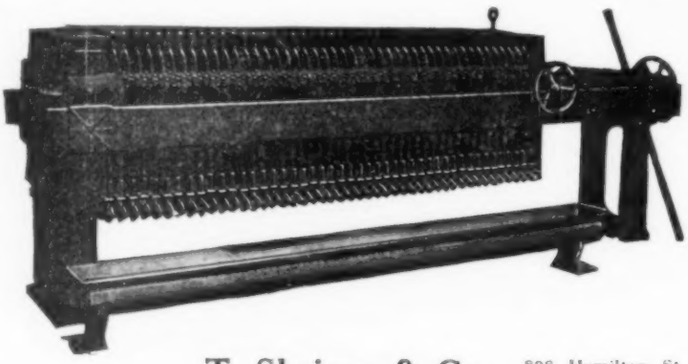

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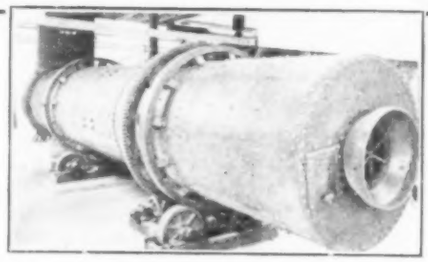

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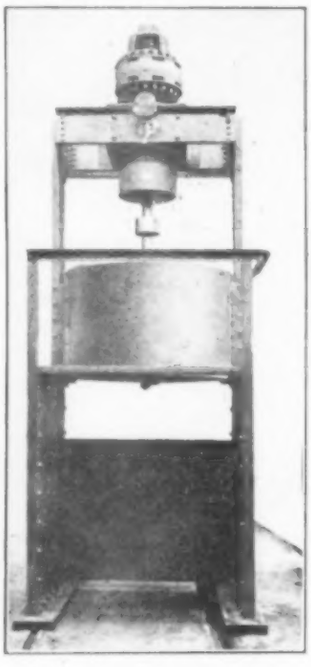
CHEMICAL CENTRIFUGALS



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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

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The One And T'other

TWO members of the editorial staff were in conference. We shall refer to them as One and T'other. "I don't know whether my reading has been ill-chosen or not," said One, "but somehow I find little in current journals except complaint and grumbling about persons and parties in opposition. The only agreement I find is that everything is going to the devil, and, to prove it, it seems as if any old argument would do. If I look into the *New Republic* it almost appears as if the cats and dogs were upon us because we do not invite the cats and dogs to have their way and rule us, whereas from the *Review* I gather that the great threat of our dissolution is the healing balm of the *New Republic.* That the Hearst papers should stir up hatred and anger is to be expected, for this is their meat and drink; but publications that have heretofore been edited with conscience are charging either President WILSON or Senator LODGE with guilt for all the evils that may come upon us. Have we become a nation of common scolds? Have we no more constructive minds? Were our thinking men killed in the war?

"All this leads me to believe that it is high time for us to take a hitch in our belts; to put an end to unceasing complaint and to think up things that are worth while. The way to get out of misery is to plan to get out of it, and it looks to me as if most present efforts were addressed to inviting it to come in and overwhelm us. That would prove the contentions and fulfill the prophecies of nearly everybody. This thing is unwholesome and it doesn't help a little bit. Don't you think it would be timely to sound the slogan to call for more ideas and less poison gas? The blamed thing is getting on my nerves! I feel that people should turn over a new leaf and attend to business. Then we may find that things are not so threatening after all, provided always intelligent persons will use their heads rather than their wrath.

"The subject isn't exactly within our province, but I think the idea should be put over. What do you think about it?"

T'other editor spoke of the complimentary dinner given at the Waldorf to HENRY P. DAVISON on the preceding Saturday night. One had not been there, while T'other had, and the latter said that he too had had the material for an editorial in the back of his head, that during Mr. DAVISON'S speech it had assumed form, and, although the roads were different, it might be that the conclusions drawn were similar.

It appears that there were between 700 and 800 persons present at the dinner, and the preliminary laudatory addresses about the chairman of the War Council of the Red Cross were of a sort to make him very proud. But when the guest of the evening, who had won his way to fame and fortune by sheer ability, was called on to reply, after making acknowledgment of the words of praise, he stated that he would not apologize for the time he might take or for what he was about to reveal.

And there followed a picture of middle Europe, from the Baltic down through Poland, Czechoslovakia, Austria, Rumania, Serbia, Albania and Armenia that was drawn from facts. Famine stalks throughout the continent. Disease, especially typhus, is a plague. So is tuberculosis. There are no medicines. There is no sanitation. Over most of the territory there are hardly any doctors and such as there are lack all facilities. One doctor to from 50,000 to 100,000 persons with neither medicines nor transportation facilities couldn't do very much, and this is the situation over a great part of the area. The land is neglected and the people are flocking to the cities. Government changes in name every few weeks, but only in name. It does not exist in fact. Money has no value, so they cannot buy. In Vienna an ordinary automobile sold for sixteen times the former yearly salary of the Prime Minister. A mania for dancing has arisen in that great city where there is not one meal a day for the population, and wherever there is music the hungry people gather and dance until they fall exhausted. "That is not joy," said the speaker; "it is madness." When Russia changed her coat and fought for the Germans instead of against them she took 300,000 Allied soldiers and put them in a camp. There are 150,000 of these left alive and they will not last much longer.

These are just a few points of the speech that T'other editor recalled. Then he quoted some more.

"What do Europeans think of America now?" asked the speaker. "They say," he replied, "that we came over and helped magnificently; not because they called us, but for a great principle. When the Armistice was signed the President himself went over to make sure that principles of liberty should be included in the terms of peace. They say they believed that the great power and influence and ability of the American people were with them to secure a righteous peace, to read its terms into the treaty, and to help in the organization of reconstruction, which is one of the most difficult of human undertakings, especially among war-worn, crippled and distracted peoples. Then, they say, we have turned our backs on them. But now," he continued, "we have to do with the situation and not with what they say." And he declared it as his conviction after serious deliberation that the situation had got beyond the control of private initiative. It is so horrid, so ghastly, so immense, that only governments can stem the tide. England has been sorely stricken.

but she is coming through. She can take care of herself. France needs materials, and the country has been wretchedly mangled, but she has grand courage and she will take care of herself. The same may be said of Italy. The United States, on the other hand, is the only nation that has in abundance what that broad strip of hell needs. If the matter is taken in hand by our own Government, without the blight of politics at either end, and provision made for an army of mercy with doctors and food and sanitary engineers and the capacity to maintain order among people crazed by want and grief and misery, then England will follow to the limit of her ability, Japan will come along, and so will Holland and the Scandinavian countries and through a mighty effort the human conflagration may be extinguished. But if we do not do this thing; if we declare that it is none of our business and let them rot, the greater danger is not remote, but very near and very pressing, that all human effort will be unable to put down the triumph of madness over civilization.

"There," said T'other editor, "is the thing we need: the big vision, the big view. All of a sudden it seems as if the American people had dwindled, become little and mean and shabby in character. The big things we did before and during the war are all over with, and now we squabble. But even if this has become an epidemic degeneration of the mind, and men who once stood with clear vision, looking ahead, are now screaming in the halls of Congress like fighting cats and we have learned to despise them, it is no excuse for us if we imitate them. The world is in a parlous state and there's trouble in the air. The public intelligence is not high; not as high as it usually is. The popularity of some political candidates shows this. So the only safe attitude for thoughtful men is to take the long view, to look far ahead and to play the game fair. There never was a time when the responsibilities of every thinking man were so great and pressing as they are today."

And the editors agreed that at this point was the meeting of the roads. The more we mind our obligations the less we need fear for our rights. The Golden Rule still holds!

Senator Moses Answers a Question

MANY years ago there used to stand on Broadway near Wall street an old peddler who sold gum-drops; a grinning old remnant that appeared to enjoy his day at the market without doing anything, for we never saw him make a sale. He merely offered his wares—and smiled. Some wag had hung about his neck a sign which he maintained through the years as his contribution to the cheer of life until—and this, too, was long ago—he disappeared with other sweepings. The sign read "Terrible Excitement! Ferocious Slaughter of Prices! Giant Gum Drops Formerly 2c. Each Now 3 for 5c."

We are reminded of the episode by one of similar subtlety lately recorded in the transactions of the United States Senate. The Honorable GEORGE H. MOSES of Concord represents the sovereign State of New Hampshire and within that Commonwealth large quantities of dyes are used. Just as one star differeth from another star in glory, so one textile manufacturer differeth from another in opinion. We have no census of opinion of the New Hampshire mill authorities in regard to the pending legislation to maintain the coal-tar dye and allied industries as American institutions, but probably some favor the Senate bill and some hope for its defeat with a view to getting cheaper dyes from Germany pretty soon. We are also without specific information as to the relations of Senator MOSES with various textile manufacturers of his State, nor do we know what co-ordination of opinion as to public affairs may obtain between them. But Senator MOSES is against the dye bill; tooth and nail opposed to it. And Senator KENYON of Iowa, who back in 1914 claimed to be more "broad-minded" than the rest of us in considering the invasion of Belgium and German war methods, agrees with Senator MOSES about dyes.

Now, all persons familiar with chemical industry know that for the present this bill is necessary to maintain these establishments. Just because manufacturers usually have objected and probably will object to the lowering of duties on or the encouragement of importations of what they make, we need not be blind to present facts. The Senate bill is necessary to maintain the industry here no matter who makes money or loses it. And with it is coupled the development and maintenance of chemical preparedness for war. The American Chemical Society at its St. Louis meeting unanimously indorsed it, and neither dye producers nor any other type of manufacturer controls the American Chemical Society. To defeat the bill would be a great blow to national preparedness. Every chemist knows that.

But Senator MOSES opposes it. At the same time he is acting as advance agent for the candidacy of General WOOD for the Presidency. He went to Wilmington, Del., where he proclaimed the good General's many desirable qualities, while in Washington he had been engaged in opposition to the dye bill. Then CHARLES K. WESTON, of E. I. du Pont de Nemours & Co., wrote to Senator MOSES that he had listened with interest to his address and especially to his exposition of the General's favorable attitude toward national preparedness. Mr. WESTON also said he was outlining a publicity campaign in regard to the proposed dye legislation and he asked Senator MOSES to set him straight on the apparent contradiction of his attitude toward General WOOD's candidacy on the one hand and toward the dye bill on the other. He signed himself frankly as of the publicity bureau of the du Pont company. It is a large manufacturer of high-class dyes and is intensely interested in the industry.

The question was perfectly fair and straight. We do not understand how Senator MOSES can be at once for preparedness and against the industrial development of organic chemistry to which the dye industry is the key. To anyone familiar with the situation this is a hard nut to crack. We should like very much to have it explained. We mean intelligently rather than oratorically explained. But on Friday last Senator KENYON of Iowa arose in all his dignity and cautioned his brother Senators against the sinister influences at work, not against the bill but for it. "I have in my hand," he exclaimed, "a letter addressed to a certain Senator who is opposing this bill and is also one of the managers of the candidacy of a certain gentleman for President of the United States . . . which is . . . a threat to the Senator in relation to that candidacy if he does not cease his opposition to the bill."

This brought the thinkers in from the cloak room and Senator KENYON proceeded to say that "This letter is used with the full knowledge and consent of the Sena

tor, who *resents* it. And I am sure I ought to say that . . . General WOOD also resents the letter."

The crux of the whole matter is the resentment of Senator MOSES at a simple, honest question. We can hardly agree with Senator KENYON that he "ought to" say General WOOD resents it unless he really does; and even then it would be impolitic to advertise the fact. As a matter of fact, General WOOD was quoted Sunday as saying that he knew nothing of the letter until reading it in the newspapers. If the Senator could answer the question we suppose he would. Being unable to square himself with the facts as to preparedness, he "resents" it—and Senator KENYON makes the noise.

The Senate of the United States has not done itself proud during the last two years. The post-war degeneration in ideals and constructive thought from which the whole world has suffered has shown its incidence with peculiar sharpness upon that body. The resentment of the venerable Senator from New Hampshire is very like the great excitement of the late aged philosopher of the sidewalk. It is humorous, but not convincing.

Channels of Steel Consumption

IT IS always difficult to make even an approximate quantitative analysis of the consumption of steel in the United States. There always seems to be more steel consumed than can be accounted for, and when one comes to the item "all other," to be made up by difference, the proportion of that item is likely to be very large. The difficulty is experienced both when steel consumption is far below normal and when it is above normal. In "lean" years, like 1908 and 1914, there seemed to be scarcely any demand for steel, yet the production was at 50 or 60 per cent of capacity and there was a certain utilization of existing stocks besides.

As it is a matter of tonnage, outputs and capacities should be set down definitely. Disregarding rolled iron, which has run something like a million and a half tons a year for quite a while past, the production of finished rolled steel in 1906, when the industry operated fully at capacity throughout the year, was 17,401,911 gross tons.

As the finished product of one manufacturing process is the raw material of the next, the definition of "finished steel" must be by reference to process of manufacture. In the nomenclature employed in making up the statistics "finished rolled steel" is steel after it has experienced its last hot-rolling process, and of course also after the attendant shearing. Accordingly black plates for tinning as well as black sheets for use as black sheets or for galvanizing are considered rather than sheet bars, skelp is considered rather than welded pipe, the rods are weighed rather than the drawn wire or the rod billets, and thus with other commodities. In both 1912 and 1913 the output was a shade over 23,000,000 tons, and as 1912 saw light operation early in the year and 1913 light operation late in the year, the production and consumption in the twelvemonth July 1 to June 30 may be taken at 25,000,000 tons, likewise the capacity. In 1916, when capacity was increasing, and when late in the year transportation difficulties interfered with production, the output was 30,557,818 tons. There has not been even an approximate test of capacity since then, but the finished rolled steel output in ordinary times runs 76 per cent of the ingot output, and the ingot output in March, after continued increases for several months, was at the rate of 45,200,000 tons a year, from which it may be estimated quite accurately the rolled steel output was at the rate of 35,000,000 tons a year. Capacity under moderately favorable working conditions is about 40,000,000 tons a year, and let us hope that the estimate will soon be put to the test of actual experiment.

One is called upon, therefore, to analyze about 3,000,000 gross tons a month, or 35,000,000 gross tons a year. It is a very difficult task to find the channels of consumption that will absorb so much, but this does not suggest that the consumption does not occur or that it cannot occur for any length of time, since similar difficulties have been experienced ever since the steel industry has been in existence, yet the steel consumption of past years is an accomplished fact.

It used to be a custom to assume that "the railroads" consume 30 or 40 per cent of the steel output. It is doubtful whether that was ever true, and it certainly is not true now. The railroads will consume 2,000,000 tons or so of rails this year. Orders for steel cars have mounted to a few tens of thousands of cars. Steel wheels are included in the production statistics but cars being ordered do not all have steel wheels, so that at best twenty gross tons of steel per car would cover the case, meaning a consumption this year in car building of only between 1,000,000 and 2,000,000 tons. Locomotives will take but a fraction of this amount, and track repair material, steel for signaling and various miscellaneous uses but a fraction again of that. Car repair material, however, easily involves several hundred thousand tons, repairs lately required being so extensive as occasionally to require four or five tons of steel per car. In bridges, buildings, viaducts, etc., the railroads are doing very little. The requirements of the railroads of the country, all told, therefore, are not running much beyond 5,000,000 tons a year, and certainly they are far under 10,000,000 tons.

The individual skyscraper is an imposing example of steel consumption, but not many skyscrapers are erected in a year, and at this time such construction work is particularly rare. It is a very large skyscraper that required 10,000 tons of structural steel for the framework, and the incidentals of piping, elevators, etc., do not involve half again as much. The consumption of steel in such large buildings will do well if it runs into seven figures this year.

Estimates were that slightly more than 2,000,000 passenger automobiles would be built this year. The heavy cars are rare, the light cars numerous, and the average weight of all probably lies between 2,500 and 3,000 pounds, so that one gross ton of finished rolled steel per car would cover the case, this accounting for between 2,000,000 and 2,500,000 tons for the year, or not more than 10 per cent of the total production of the industry.

Thus far we have found about 10,000,000 tons out of the 35,000,000 tons to be accounted for. The remaining 25,000,000 tons is "all other," by difference, including agricultural implements and machinery of all descriptions, tools, hardware, pipe for oil development and transport, oil and other tanks, steel for small buildings, particularly "portable" garages, exports and a few other items.

Western Chemical & Metallurgical Field

California Fruit Growers Exchange Research Laboratory

The California Fruit Growers Exchange, a co-operative, non-profit, non-capital stock organization of 10,000 growers of citrus fruits, has established a research laboratory for the purpose of conducting investigations along fundamental lines on chemical problems relating to the citrus fruit industry. The first work of the laboratory will be in connection with the utilization of the lower grades of fruit.

Lemon growers of the California Fruit Growers Exchange in 1914 established the Exchange Byproducts Co. at Corona, Riverside County, which has since then been engaged in the production of U.S.P. citric acid and lemon oil from cull lemons. Later, the orange growers organized the Exchange Orange Products Co. for the purpose of utilizing the lower grades of oranges in the manufacture of marmalade and other products.

The research laboratory of the exchange is for the purpose of working out the problems incident to the production of new products from all varieties of citrus fruits and of co-operating with the byproducts factories in their chemical problems, while each byproducts factory has also its own plant control laboratory and chemists. Other lines of work will be taken up later.

The laboratory is located in the building of the Exchange Byproducts Co. at Corona. C. P. Wilson, for many years with the Bureau of Chemistry of the U. S. Department of Agriculture and for the last three years chief chemist of the Exchange Byproducts Co., will have charge.

Prospective Power Development in California

There are at present ninety-one power plants in the State of California which are operated by the large power companies. The transmission lines of these companies are to a large extent interconnected and more complete interconnection and the enlargement of existing connections are now under construction. Of these plants sixty-seven are hydro and twenty-four are steam; The installed generator capacity is 513,000 kw. for the hydro plants and 279,000 kw. for the steam plants, a total of 792,000 kw., or 1,063,000 hp. This is the largest system of interconnected companies in the world, the combined output for the year 1919 being more than three billion kilowatt-hours.

There are at present under construction thirteen power plants with a total installed generator capacity of 270,500 kw.; of this, 85,000 kw. will be steam generated. These additions, listed below, will be completed within a year and indicate a total installed primary in condition for operation in April, 1921, of more than 1,400,000 hp.

The outstanding feature of these developments is not the magnitude of the installed power, but the fact that the various plants are interconnected and the length of the interconnected transmission lines, which extend from Oregon to Mexico. One essential requirement for power to be supplied to industries is reliability; the interconnection, together with the favorable climatic conditions, practically assures this. Taken together with weather which permits of maximum production throughout the year, this will result in California becoming an increasingly important industrial section of the country. Statistics recently published by the *Electrical World* indicate that approximately 10 per cent of the potential power is now developed in Californa, which practically assures the future supply.

	Power	Kw.
City of Los Angeles:		
San Francisquito Creek, July 1, 1920	Hydro	20,000
San Joaquin Light & Power Corp.:		
Bakersfield, June 1, 1920	Steam	12,500
Kerckhoff, Oct. 1, 1920	Hydro	30,000
McKittrick, Jan. 1, 1921	Steam	15,000
Southern California Edison Co.:		
Big Creek, Nov. 1, 1920	Hydro	16,500
Kern River No. 3, Nov. 1, 1920	Hydro	30,000
Long Beach, March 1, 1921	Steam	35,000
Big Creek No. 8, March 1, 1921	Hydro	22,500
Pacific Gas & Electric Co.:		
Oakland, Nov. 1, 1920	Steam	12,500
Pitt River, Jan. 1, 1921	Hydro	24,000
Los Angeles Gas & Electric Corp.:		
Los Angeles, Jan. 1, 1921	Steam	10,000
Southern Sierras Power Co.:		
Adams Plant, Jan. 1, 1921	Hydro	2,500
Great Western Power Co.:		
Feather River (Caribou), March, 1921	Hydro	40,000
Total		270,500

The Smelters Steel Co.

The Smelters Steel Co., of Seattle, Wash., is now producing soft gray iron castings of unusual toughness and purity from magnetite iron ore in an electric furnace in one operation. G. Lewis Casey has been working on the problem for many years and has developed the process to such an extent that economic success appears to be assured. There is a good market on the Coast for soft gray iron; unfilled orders at $65 per ton indicate that the quality of the product is satisfactory to the consumers.

The company's plant, which consists of a modern foundry building and fireproof transformer room, is located on a 5-acre tract, with about 1,000 ft. of water frontage, at Seattle. Four 440-kva. transformers are already installed. One furnace is in operation, a second under construction, and as soon as this is finished two additional furnaces are to be built; the estimated output will be 15 tons per day.

Magnetite iron ore, containing over 52 per cent iron with but small amounts of deleterious impurities, is obtained from an extensive deposit on Dean Channel, B. C. The deposit is at tidewater and the ore can be easily bunkered for shipment by boat to Seattle. In addition to the ore deposit the company owns a valuable water power near the mine and a tract of timber land. The manufacture of charcoal will be undertaken.

The British Columbia Government is particularly anxious to develop an iron and steel industry within the province and negotiations are now under way with the Smelters Steel Co. looking toward the establishment of a smelting plant at the mine. With the iron bounties act, assuring $3 per ton on all pig iron produced, and with further possible assistance from the iron ore supply act, the erection of a plant costing approximately $500,000 at the mine at no far distant date seems a possibility.

The Metallurgical Research Department of the Utah State School of Mines

Equipment of a Wide Variety of Types Is Available for Testing Ores in the Intermountain Region—Besides General Work in Ore Dressing, This Station Is Doing Much Work on Chloride Volatilization and Oil Shales

By L. W. CHAPMAN

THE Metallurgical Research Department of the State School of Mines was established by the Utah Legislature in 1913 for "finding ways and methods of profitably treating low-grade ores, of securing a higher percentage of extraction of metals from their ores, for obtaining other information that shall have for its object the benefit of the mining industry and utilization and conservation of the mineral resources of the state and for the publication and distribution of bulletins."

By an agreement with the United States Bureau of Mines the work of this department is under the direction of metallurgists of the Bureau assigned to duty with headquarters at the University of Utah.

At present the technical staff of the U. S. Bureau of Mines connected with this department is as follows:

Thomas Varley, metallurgist in charge.
C. A. Wright, hydrometallurgist.
J. C. Morgan, assistant chemist.
E. P. Barrett, assistant chemist.
R. E. Head, metallurgical assistant.
H. D. Gavin, refinery engineer.
L. C. Karrich, junior refinery engineer.

The present staff of the Department of Metallurgical Research, State School of Mines, University of Utah, consists of:

Joseph F. Merrill, director.
R. H. Bradford, professor of metallurgy.
Robert S. Lewis, professor of mining.
J. R. Phoenix, analyst.
H. W. Clark, laboratory assistant.

From 1913 until the Legislature met in 1919, $7,500 had been appropriated yearly by the state to carry on this research work. The last Legislature, however, increased the amount $5,000 a year and appropriated $25,000 for the ensuing two years. During 1918 certain mining companies and business men of Salt Lake City and other parts of the state subscribed $21,000, which, together with an additional $15,000 appropriated by the state, was used for the enlargement of the buildings, increasing library facilities and remodeling and buying new equipment for the ore-dressing and metallurgical laboratories.

A large fireproof building (shown in Fig. 1) 75 ft. long, 40 ft. wide and two stories high has been erected and the offices of the U. S. Bureau of Mines and the Department of Metallurgical Research, as well as laboratories and lecture rooms, have been installed.

Up-to-date machinery for ore dressing and flotation and other equipment necessary for properly carrying on research and experimental work have been installed, making one of the most complete and up-to-date laboratories of its kind in the United States.

Provision has been made for six fellowships during the fiscal year 1919-1920. Each of these fellowships pays an annual income of $720 and covers a period of twelve months. The holders of these fellowships are required to register for courses of instruction in the University of Utah and become candidates for the master's degree, and, while these "fellows" are under the general direction of the metallurgist in charge, the detailed supervision is under other Bureau of Mines metallurgists and chemists and the professors of mining and metallurgy of the University of Utah.

Ore-Dressing Laboratories

For testing ores by gravity concentration and flotation it is necessary that the laboratories should be designed to handle ores in amounts varying from a sample of only a few pounds to lots of several tons in weight. The sampling room for the metallurgical laboratories is equipped with all machinery necessary for fine grinding and the reduction of comparatively large samples to small and easily handled bulk. The equipment consists of an Allis-Chalmers gyratory sample grinder, a Universal jaw crusher having an opening 3½ x 6 in., Allis-Chalmers laboratory rolls 4 x 9 in. in size, a McColl disk pulverizer having 9½-in. disk, and an Iler disk pulverizer having 6-in. disk. Five sets of Jones sample splitters of different sizes are used for cutting out the final sample.

Some special grinding has been done on graphite ores. For this purpose a 12-in. Burr mill of Sprout-Waldron manufacture has been installed.

The designs of modern concentrating plants are usually based upon the results of small-scale tests on the ores to be treated. These tests are generally divided into two classes. The first or preliminary testing is

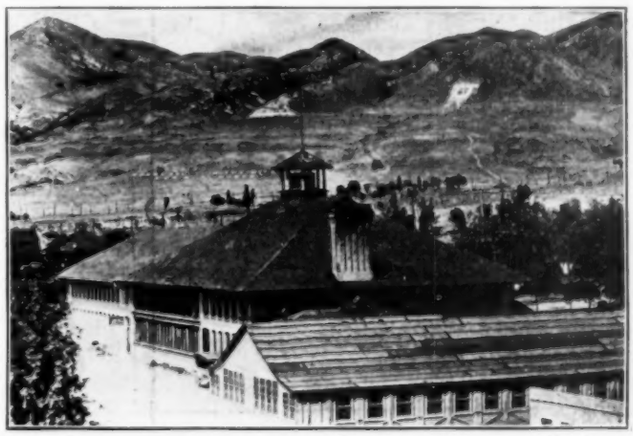


FIG. 1. METALLURGICAL BUILDING, UNIVERSITY OF UTAH

done on lots of a few pounds only. The larger or controlling tests are carried out on machines which will handle from 150 lb. to as much as a ton of material in an hour. Experience indicates that the results obtained from the first or preliminary tests, if they are carefully done, give a very reliable indication of the work to be expected in the larger testing plant and also in the commercial mill.

For the work of coarse concentration two Hartz jigs are available. The larger jig has two compartments, each 7 x 15 in. in size. The smaller jig has two compartments, each 4 x 6 in. These jigs have an automatic concentrate discharge and the usual adjustable eccentric drive. For the work of fine concentration several tables are available, a Wilfley table 12 x 24 in., a 15 x 30-in. Deister Plat-O table and an Overstrom Universal table 18 x 44 in. The effect that different styles of riffling may have is noted by using interchangeable table decks.

There is also a half-size Deister-Overstrom finishing table which is set up independently of the other ma-

FIG. 2. PART OF FLOTATION LABORATORY

chines and is provided with a mechanical feeder with a capacity of approximately 75 to 100 lb. of ore, which can be fed at a uniform rate over this table. There are also two half-size Wilfley tables which can be riffled according to the nature of the ores and sizes treated.

The laboratories are equipped with a small ball mill with a capacity of 3 kg. (7 lb.) of ore, which makes it possible to crush any wet material to be treated by flotation.

An Abbe jar mill equipped with Silex pebbles is also provided, with a capacity of approximately 3 kg. of ore. By having the two kinds of fine grinding mills, it is possible to get comparative data on the effect of crushing with iron balls against iron with that of pebbles against Silex lining.

Flotation Laboratory

The flotation laboratory (Fig. 2) is equipped with a variety of testing machines, of the mechanical, pneumatic, and combination types. These consist of a small Callow testing machine operated entirely by air agitation; a Jones-Belmont machine, having a capacity of about 2 kg. (4.5 lb.) of ore, which is a combined air and mechanical agitation machine; a small K. & K. machine which is an aërating and a mechanical type machine, and a Federal-Varley machine which is the straight mechanical agitation type somewhat similar to the M. S. machine, having a capacity of from 3 to 5 kg. (7 to 12 lb.) of ore. There are also two small Janney laboratory size machines which are used for small-scale straight mechanical agitation tests, and a Ruth flotation machine which is of the mechanical agitation type, the impeller being arranged in such a manner as to create a suction of air through the hollow impeller.*

These machines differ in size and capacity so that samples ranging from ½ to 5 kg. (1 to 12 lb.) can be treated at a time.

Suction filters are used for dewatering the products, and gas and steam heaters are provided for drying all the products made. A small Root blower is provided in the laboratories which gives the proper amount of air for the pneumatic machines. This can be controlled in order to give any volume or pressure desired.

A large supply and variety of various flotation oils and other reagents used in flotation are kept on hand. These are renewed from time to time, as it has been found that the oils change their characteristics somewhat in long standing.

Arrangement of Equipment for Tonnage Tests

The object of having the equipment arranged for large-scale tests so that quantities of a ton or more of ore can be handled at one time, applying the same treatment as that given in commercial concentrating plants, is twofold:

First, so that the results of the small-scale tests may be substantiated by larger scale experiments.

Second, so that students of the School of Mines and Engineering may have a chance to carry out tests under direction and thus gain experience of operating the various machines and also of making the metallurgical calculations that are required in a report on a complete concentration test.

The keynote of the large-scale testing laboratory is flexibility; an ore can be crushed to comparatively coarse size and can then be treated on jigs or, after fine grinding in one of the various mills, it can be treated on concentrating tables, on slime tables, or by flotation. If a complex lead-zinc-iron ore is to be tested, provision is made either for regrinding the middling or for drying and roasting the same, followed by magnetic separation of the zinc and iron.

The crusher used is of the Dodge type, size of opening 7 in. x 9 in., speed 260 r.p.m. The usual size of the crushed product is from ½ to ¾ in., a size most suitable for the set of Allis-Chalmers 12 x 16-in. rolls operating at a speed of 155 r.p.m. These rolls can be set to crush to any desired size, but usually produce material ¼ in. or under. From the rolls the ore passes to an elevator having a lift of 32 ft., delivering the product to screens.

The first screen is a double-cone trommel 30 in. long. The inner screen has ⅜-in. holes and the outer screen ¼-in. holes, and is used to give a product suitable for further sizing with a Mitchell vibrating screen. This screen has a large capacity, is very efficient, and can be readily changed so that any desired size can be obtained as an undersize product.

Ball Mills and Fine Crushing Equipment

When fine crushing for table and flotation concentration is desired, the undersize material from the first screen passes directly to two storage bins, each holding approximately one ton. From these two bins the

*For a general description of most of these machines see an article by Fahrenwald in CHEM. & MET. ENG., vol. 19, pp. 77 and 129.

ore can be distributed to any one of four grinding machines together with necessary amount of water.

(1) A No. 32 Marcy mill in which steel balls are used as the crushing medium. The mill has a maximum capacity of about one ton per hour at 35 r.p.m. when crushing to 8 mesh. The overflow or slime goes to a pump.

(2) A 3-ft. x 8-in. Hardinge conical mill, using either flint pebbles or steel balls as the grinding medium and operating at 28 r.p.m. The discharge from this mill or the Marcy mill may be sent to a Dorr classifier, the oversize being returned to the mill for regrinding.

(3) A 3½-ft. Huntington mill operating at the rate of 80 r.p.m. Screens are used to control the size of the product from the mill.

(4) A stamp mill provided with three 250-lb. stamps. The drop is 6 in. and rate 90 r.p.m. These stamps are used for crushing ores that contain free gold or silver. An amalgamation plate, 24 in. wide x 48 in. long, is also provided directly in front of the stamps.

All crushed material and the overflow from the Dorr classifier are pumped to the second floor of the mill building, where they are discharged into a mechanical classifier of the Dorr, Akins, or Esperanza type. The sands can be sent either to a three-spigot hydraulic classifier, which supplies a classified feed to the concentrating tables, or to a single Deister cone baffle classifier, which gives a table feed of any desired size.

Tables

The table equipment, shown in part in Fig. 3, includes two Wilfley tables with decks 3 ft., 4 in. x 7 ft., 6 in. long, one Deister-Overstrom finishing table, with deck 3 ft. wide x 7 ft. long, and one Overstrom roughing table of approximately the same area. The riffling on these tables can be changed and the speed of the table and length of stroke regulated.

Flotation Equipment

The flotation equipment consists of a Janney flotation machine patterned after the standard Janney machine and is of the combined mechanical and air type. This machine treats several tons of ore per day and does excellent work on small lots. The rate of feed is under perfect control and the amount of oils used is carefully regulated. By special arrangement the first or rougher concentrates can be stored and re-treated or cleaned in the same machine.

A flotation machine was furnished by the Arzinger Machinery Co., Nashville, Tenn., which has been successfully used in floating the graphite in the ores of the Alabama graphite fields and on the zinc ores in Tennessee.

A straight mechanical, two-compartment M. S. flotation machine with a variable speed motor completes the equipment.

When treating complex lead-zinc-iron ores it is often necessary to give middling products from the tables a slight roast in a furnace in order to make the iron magnetic. The furnace product is then treated in a three-magnet laboratory-size Campbell magnetic separator. Each pole is connected with a meter and rheostat regulating the fields so that the poles can be given different magnetic intensities. In the case of many chromium and manganese ores this magnetic separator can be used to separate magnetite, garnet and other ingredients from the chromite and manganese.

Considerable work has recently been done on the massive low-grade alunite deposits from Piute County, Utah. Experiments have been made with the idea of economically obtaining potash from the ores by a simple roasting-lixiviation process. The objects of the tests are as follows:

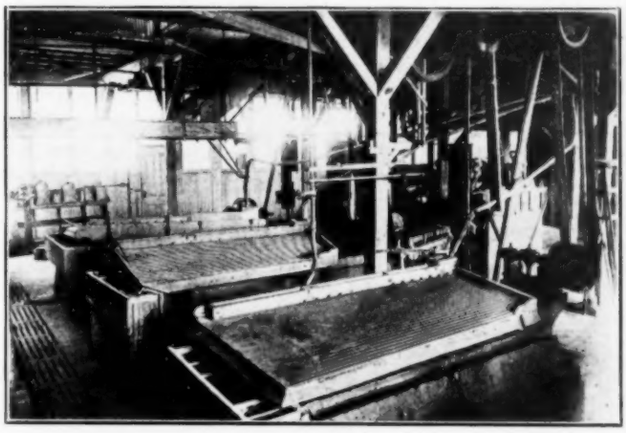


FIG. 3. PART OF ORE-DRESSING LABORATORIES

1. The roasting temperature best adapted to a high recovery of potash by subsequent lixiviation.

2. The size of crushed ore which on roasting at the most desirable temperature gives the best extraction-crushing economy.

3. Whether there is a loss of potash by volatilization during roasting operations.

Further tests on a large scale are now under way. These tests are to be carried on with the object in view of recovering the alumina as well as the potash.

Chloride Volatilization Process

The chloride volatilization process has recently been applied with considerable promise of success to the recovery of metal in oxidized ores and is one of the major problems being studied. The process, briefly stated, consists of the following steps:

First, crushing to a degree of fineness depending upon the character of the ore.

Second, mixing with chloridizing agents either alone or with other reagents. Sodium and calcium chlorides have been found to be effective chloridizers. Sulphur, either in the form of natural sulphur or as pyrite, has been found to aid in chloridizing, as has also lime, although the general effect of these reagents is yet to be worked out.

Third, furnacing to effect chloridization and the volatilization of the metal chlorides formed.

Fourth, recovery of the volatilized metal chlorides.

Fifth, treatment of volatilized chlorides to obtain the values in salable form, preferably with regeneration of the reagent.

Chloridization of the precious metals prior to subsequent lixiviation is an old practice. Volatilization of metals as they form into chlorides was a recognized source of loss and in practice was naturally to be avoided. Not until 1901 is there any record of an attempt to put this loss by volatilization to any gain. At this time, Messrs. Poole and Croasdale, using salt and sulphur, endeavored to volatilize a high percentage of all the valuable metals contained in the ore. Although not financially successful, due primarily to failure to collect the volatilized chlorides economically, their endeavor established the possibilities of this process.

The successful application of the Cottrell electric precipitator in the removal of solids from smelter gases was an important factor in the revival of the volatilization process and finally the feasibility of chloridizing and volatilizing the metals from ores by the use of a salt roast without the use of sulphur was established, at least for certain ores.

Crushing

The fineness to which ore must be crushed is dependent upon the character of the ore. Preferred practice with those ores which respond best to volatilization is to crush not finer than through 30-mesh. Such crushing involves the use of both crusher and rolls. Reagents must also be crushed to a fineness corresponding to that of the ore to give the best results.

Reagents

Two reagents have been successfully applied as chloridizing agents—sodium and calcium chloride. Extractions obtained with these two chloridizers vary with different ores and different metals, and while neither is uniformly better, common salt, being cheaper in western localities, will undoubtedly be used as the primary chloridizing agent. Present indications are that a slag consisting chiefly of calcium chloride will result from the reduction of the fume in most cases and will be re-used as a chloridizing reagent.

Besides the chloridizing agents, sulphur, pyrite and lime have been found to be beneficial with certain ores.

Reagents and ore are thoroughly mixed to insure intimate contact.

Furnace

Ore, after being mixed with the desired reagent, is fed into a horizontal cylindrical kiln similar to those used in cement mills, where the mixture is heated to effect chloridization and volatilization. On amounts of material of 100 lb. or over there is available a kiln 20 ft. long with an inside diameter of 13 in. for the last 15 ft. and 21 in. inside diameter for the first 5 ft. from the fire end, and also a 6-hearth Wedge roaster arranged for either muffle or direct firing. A reverberatory furnace is soon to be installed.

The cylindrical kiln is fired by an oil burner, the flame being directed into the open end of the kiln, as shown in Fig. 4. Ore is fed in by a worm feed so that it discharges into the kiln at a point about 3 ft. from the cold end, giving it a travel through the kiln of about 17 ft. The rate of revolution can be varied so that ore may be held in the kiln for periods of from one hour to two hours, one-half of this time being in the enlarged section where the maximum temperature is obtained.

Flue System and Cottrell Electrical Precipitation

The cold end of the kiln extends into a sheet iron cooling and settling chamber, where a large amount of the heavier solid particles drop out of the gases. From the settling chamber the gases pass through a short flue to a second settling and distribution chamber, where the greater part of the remaining dust particles are deposited without any great amount of the metal chloride fume. From the settling and distribution chamber the gases pass up through a flue and discharge by passing down through a small Cottrell precipitator. After passing through the precipitator the gases are to a large extent free from metallic chlorides and pass through an exhauster to the stack. No further attempt is made to clean the gases after they leave the Cottrell. At the present time this phase of the problem is receiving considerable attention.

The Cottrell precipitator at the Salt Lake City station is constructed in two units, each with a capacity of 1,500 cu.ft. of gas per minute. The units are 17½ ft. high x 4½ ft. square over all. Each unit receives the gases through a 15-in. pipe to the top chamber of the treater. The gases pass from the top chamber to the bottom chamber through twenty precipitating tubes; these are 6 in. in diameter and 8 ft. long. Gases are exhausted from the bottom chamber into the stack by an 18-in. fan. The units are exactly alike, and so arranged with slide dampers that either one or both of the treaters can be used at any time. The discharge electrodes are made of chromel wire.

The treater transformer is rated at 5 kva., 220-440/100,000 volts. The rectifier has a disk 36 in. in diameter and is driven by a 3-hp. synchronous motor at 1,800 r.p.m. The control of the voltage of the transformer is obtained by means of an auto-transformer which is arranged to supply power at any voltage between 55 and 440 by steps of 55 volts. A theater dimmer is used for the control between the auto-transformer voltages. By this arrangement any voltage from about 5,000 to 100,000 can be obtained from the secondary of the high-tension transformer.

Treatment of Fume

The fume, consisting of metal and sodium chlorides as collected in the treaters, must next be treated for the recovery of the contained metals. At present this part of the work is the least advanced of any, but is being taken up as one of the most important problems of the process. It is probable that the fume from each ore will in itself offer a distinct problem, although these

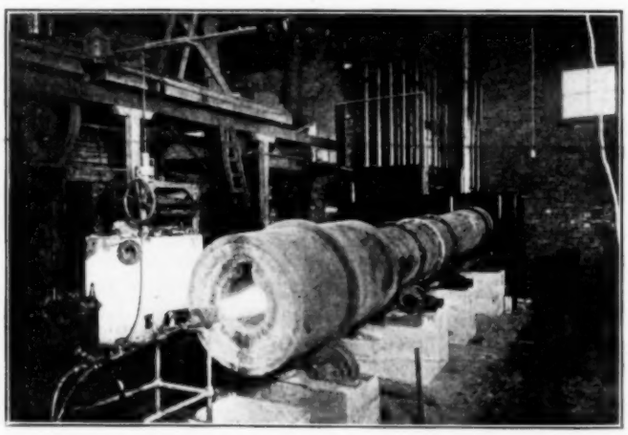


FIG. 4. VOLATILIZATION KILN

fumes will fall in a few general classes. Four general classes have already been met with as follows:

First, lead-silver-gold fumes; second, copper-silver-gold fumes; third, lead-copper-silver-gold fumes; fourth, very complex fumes, as for instance lead-zinc-copper-mercury-silver-gold fumes.

While no general statements as regards the treatment of the fume can be made, several solutions are suggested. First, it may be leached, with subsequent precipitation of the metal from the leach liquors; this method of treatment will probably be resorted to, partially at least, in treating the complex fumes; second

metal may be directly reduced from the fume; this is accomplished by mixing the metal chlorides with lime and a reducing agent such as coke, and heating to a temperature above the melting point of the metal being reduced. The products formed in this case are bullion and a slag composed chiefly of calcium chloride. It seems probable that this method can be applied to such fumes as lead-silver-gold or copper-silver-gold combinations.

Ores Amenable to Volatilization

The volatilization process at the present time seems to have its greatest application to low-grade oxidized ores. The best results have been obtained with simple low-grade lead ores, copper ores, lead-silver ores and

FIG. 5. CHEMICAL LABORATORY

copper-silver ores. Considerable success has been met with also in the more complex oxidized ores carrying copper, lead, silver and zinc, although the last named is not volatilized with any very great degree of success. Little general success has been met with so far on the treatment of complex sulphide ores, although evidence indicates that it may be possible to treat this type of ore after the behavior of the simpler oxidized ores during volatilization is more generally known.

Oil Shale

Investigational work on oil shales has been carried on at the Salt Lake City station for over a year. The work thus far has been along two lines, (*a*) study of methods of assaying oil shales for commercially recoverable oil and ammonium sulphate, and (*b*) investigations of a retorting plant together with a study of the products produced by it from different shales of the Rocky Mountain country. Both these investigations are practically completed, and have given valuable information as to the nature of the products to be obtained from oil shales and as to the best methods of treating the shales themselves.

Messrs. Gavin and Karrich intend to produce sufficient oil from shales to make a study of the refining of the oils on a scale large enough to determine the commercial value of the refined products.

The Bureau of Mines at the Salt Lake station has accumulated a large amount of data pertaining to all phases of the oil-shale industry, both in order that the investigators for the Bureau could have easy access to the best literature and data on the subject and that the Bureau might be well equipped to answer inquiries and requests for information on the subject of oil shale.

In order to handle rapidly the large volume of analytical and chemical work necessary in making metallurgical tests, the Salt Lake City station is equipped with three laboratories: the main chemical laboratory, shown in Fig. 5, the fire assay laboratory and the fellowship laboratory. Together they form a laboratory system equipped with all modern appliances necessary for rapid and accurate work.

The microscopic examination and study of the physical characteristics of the complex ores has been one of the problems which has received considerable attention. Methods of preparation and study developed during the course of the investigation have resulted in the discovery of many mineral relations in complex sulphide ores, the knowledge of which has been of much value in determining the treatment to which the ore would be more amenable.

The U. S. Bureau of Mines in its co-operative work with the University of Utah maintains an excellently equipped microscopic laboratory in the metallurgical building, and this phase of investigation is applied to the problems in ore-dressing which constitute the work of the station.

Acknowledgment

The material for this description was kindly furnished by Thomas Varley, metallurgist in charge of the Bureau of Mines Station, supplemented by their Bulletin No. 11.

Foreign Trade of Australia for 1918-19 Shows Increase in Exports

Detailed figures of Australian imports and exports for the fiscal year ended June 30, 1919, as published at the end of the calendar year, show the value of imports to be £93,485,050, and the exports £106,805,985, an excess for exports of £13,320,935. A summary of the foreign trade for the four months of the new fiscal year, July-October, shows that the excess of exports was increasing, for with imports totalling £24,750,555, a reduction of £6,998,650 from the figures for the corresponding period of 1918, the exports for these four months increased about 40 per cent, or from £25,724,252 in 1918, to £46,726,503 in 1919. Almost half of the year's exports came under classification VI, "animal products, mainly unmanufactured, not foodstuffs." The amount for the fiscal year was £47,665,869, of which £42,766,775 represented wool, and £4,403,518 hides and skins. Meats were exported to the amount of £8,862,246.

Exportations of wheat totaled £11,334,665, and flour £5,818,785. In the four months July-October, 1919, exports of Class VI, defined above, were £18,476,285, animal foodstuffs £6,954,665, and vegetable foodstuffs £13,661,407. New South Wales was the largest exporter in these four months, with a total of £17,354,323, and Victoria ranked second with £15,192,284.

The largest items of import for the fiscal year were textiles, amounting to £25,956,450; wearing apparel, £3,812,453, of which hosiery comprised £2,098,897; tinned plates, £1,134,337; paper, £5,390,960; timber, £1,359,251; drugs and chemicals, £4,016,447; rubber manufactures, £1,164,317. In the four months of the new fiscal year importations of textiles and wearing apparel were less than half of those of the same months of 1918, while importations of machinery nearly doubled, an indication of the rapid growth of the movement to make Australia self-sufficient in the matter of clothing.

Photographing Etched Sections at Low Magnifications

By J. H. G. Monypenny
Chief Metallurgist, Brown, Bayleys Steel Works, Ltd.

THE advantage of being able to photograph sections of steel at low magnifications, using the same type of illumination as is used for higher magnifications, i.e., vertical illumination, has been apparent to those employed in metallurgical laboratories for a considerable time. Methods somewhat similar to those described in the short article by F. B. Foley in CHEMICAL & METALLURGICAL ENGINEERING, vol. 21, p. 140 (Aug. 1, 1919), have been in use in the writer's laboratory for a number of years. As these methods differ in certain details from that described in the article mentioned above, a description of them might be of interest.

For very low magnifications (up to about four diameters) the method employed is practically the same as that described by Foley. The lens used is a 5½-in. anastigmat and with the length of camera available in our laboratory, reproduction from natural size up to

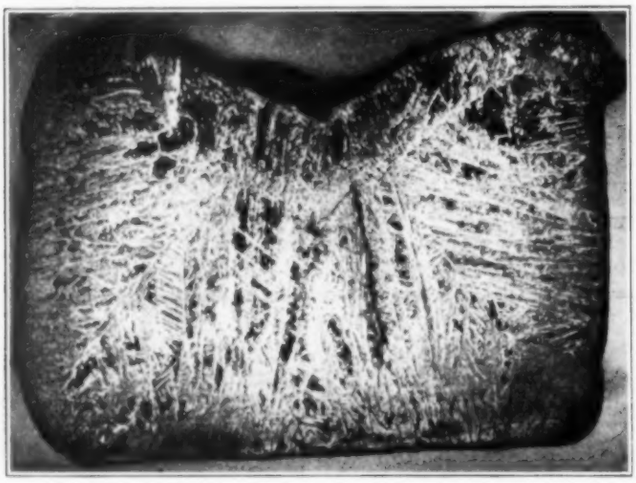


FIG. 1. LONG DENDRITES FROM CHILLED TEST-INGOT. ETCHED WITH COPPER REAGENT. × 3¾

four diameters may be obtained. Such magnifications are especially valuable with sections etched with one of the "copper" reagents (such as Stead's, Rosenhain's or Le Chatelier's). These require a low magnification to simulate macroscopic examination as a general rule. Fig. 1 (3¾ diameters) is an example of this. It represents a section from a small sample ingot taken for analytical purposes from an electric furnace, and shows the development of long "chill-crystals." Fig. 2 (from a file blank burned in forging) was also taken by this method and shows (2¾ diameters) the decarburization formed both on the skin and around the cracks.

When illuminating these large sections one should

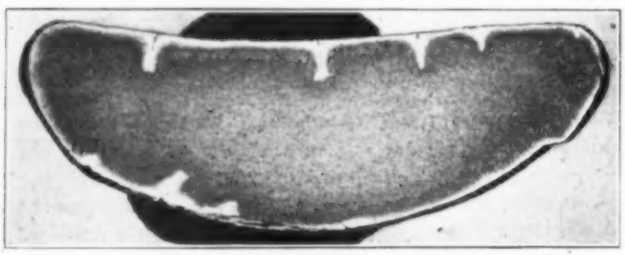


FIG. 2. FILE BLANK BURNED IN FORGING. ETCHED WITH COPPER REAGENT. × 2¾

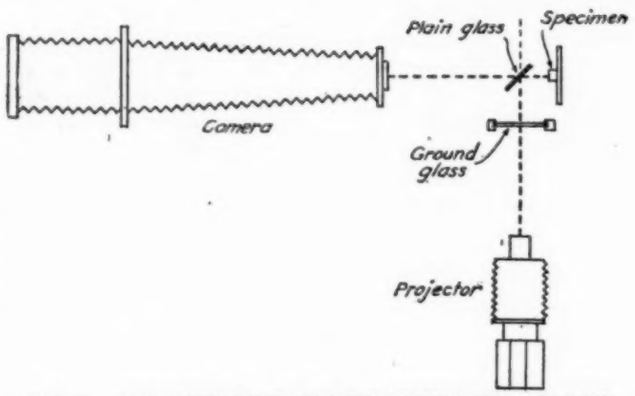


FIG. 3. ARRANGEMENT FOR PHOTOGRAPHY AT LOW MAGNIFICATIONS GIVEN IN FOLEY'S ARTICLE

endeavor to produce an evenly illuminated area, considerably larger than the section, on the ground glass (shown in the diagram, Fig. 3, from Foley's article) and the latter should be placed quite close up to the section.

For higher magnifications a 35-mm. projection lens (made by Zeiss) is employed by us, giving a magnification from nine to twenty-five diameters (with the minimum extension available on the camera a magnification of nine diameters is obtained—less could be obtained with a camera closing to a greater extent), and for these a somewhat different method of illumination is used.

If one is using an enlarging lantern or a projection lantern, then, in order to get satisfactory lighting, the condenser must be close to the negative or slide and must focus the illuminant on the projection lens, as is well known. The same principle is used for photographing sections and the arrangement of condensers is shown diagrammatically in Fig. 4. This sketch shows the 35-mm. lens *A* attached to the microscope tube and the section *B* on the stage. The microscope used is the large "works" model made by Watsons, London, which has a very wide tube—the inner draw tubes are removed for use with this lens. Condenser *D* forms a considerably enlarged image of the illuminant *C*, which now is a 500-cp. Pointolite lamp, a tungsten arc lamp made by the Edison Swan Co. and in the writer's

FIG. 4. MONYPENNY'S ARRANGEMENT FOR MAGNIFICATIONS OF 9 TO 25 DIAMETERS, USING 35-MM. ZEISS PROJECTION LENS

experience the best illuminant yet devised for photomicrography.[1] Such enlarged image is focused at *E*, close up to the second condenser *F*, and the latter in turn focuses the image, after reflection at the 45-deg. cover-glass reflector and the surface of the specimen, on the lens *A*, as indicated roughly by the dotted lines. The condensers used are 2½ in. diameter and 2⅝ in. focus, and it is possible to illuminate evenly a section about 1 in. diameter; this is more than required, as the field of the lens is only about ⅝ in. diameter. Figs. 5, 6 and 7 show some of the results obtained; I may add that most of these photographs were taken eight or ten years ago.

[1]See CHEM. & MET. ENG., vol. 22, p. 281 (Feb. 11, 1920).

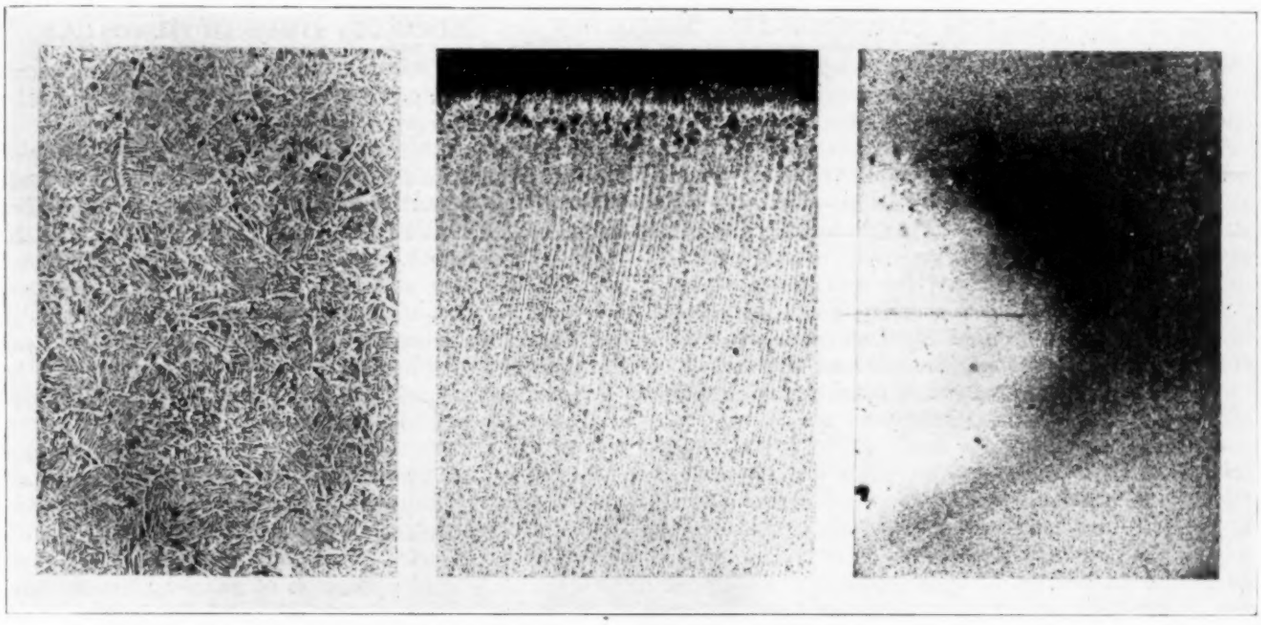


FIG. 5. OVERHEATED STEEL. × 10

FIG. 6. MILD STEEL BLOOM CUT BY OXY-ACETYLENE TORCH. × 10

FIG. 7. CARBON SEGREGATIONS AROUND AN UNSOUND SPOT. × 8

It is obvious that these low powers are of special value where either the structure is very coarse or where one wishes to show the variation of structure over a fairly large area. For example, Fig. 5, at ten diameters (originally exposed at twenty diameters), shows far better than a photograph at say 100 diameters the structure of the sample of overheated steel from which it was taken. Fig. 6 (at ten diameters reduced one-half from the original exposure) represents a section taken from a mild steel bloom cut by the oxy-acetylene blowpipe, and enables one to show in a single photograph the gradual change of structure produced. Fig. 7 (at eight diameters reduced one-half from original) illustrates another type of photograph for which the ordinary microscope objective would be quite useless; this shows the size of, and distribution of carbon in, an unsound segregated area. This actual example is rather unique, showing, as it does, high- and low-carbon areas in close proximity.

With regard to the proper exposure: Using a slow-process plate with the 35-mm. lens at twenty diameters, on a section similar to those shown in Figs. 5 to 7, two to four seconds would be required.

As mentioned above, the tube of the writer's microscope is very wide and comparatively short (2 in. diameter and 4⅜ in. long) and this enables one to use practically the full field of the 35-mm. lens; with a narrower tube, of course, part of the field would be cut off. In such cases one may do without the microscope and mount the lens on a small fitting (with either spiral or rackwork focusing) on the camera front. In one or two cases the writer has done this and has succeeded in obtaining a 6½-in. circle at nine diameters (i.e., a field of 0.72 in.). The definition in this case was not quite perfect around the edge, but it was sufficiently good for the purpose.

It may not be out of place to mention that when taking a photomicrograph without using an eyepiece it is necessary to avoid reflection from any metallic surface inside the microscope tube. The latter should be coated with a dead black varnish, but it is generally advisable to put in a lining of black cloth. Such a lining can easily be made by gumming a piece of black cloth of the required size on to a similar piece of fairly stiff paper, then rolling into a cylinder (cloth inside) which can be slid into the microscope tube.

For the 45-deg. reflector the writer uses a piece of thin microscope-cover glass 1⅞ x 1¼ in., mounted in a light metal frame which fits on the 35-mm. lens. The frame carrying the glass is pivoted, allowing the illumination to be adjusted to a nicety. The glasses may be obtained in various sizes up to 4¼ x 3¼ in., but as they are very brittle, it is advisable to use a thin lantern-slide glass for the lowest powers (i.e., from one to four diameters), which require a larger reflector.

Sheffield, England.

Wages in Japan

Commercial Attaché James F. Abbott, Tokyo, Japan, says that there is practically no regular employee now in Japan who does not get a bonus of from one to three and even five months' salary at New Year, this being a regular institution in Japan and applying to all government employees as well as to employees of private concerns. In many cases this bonus is paid twice a year, and important officials frequently receive a sum many times more than their annual salary. Another method of assisting their employees, adopted by some large factories, is to issue a rice stipend in addition to the regular salary. Some companies give board at the rate of 9 or 10 sen a day which actually costs the employer 25 to 35 sen. The employers prefer this method, as it is easier to reduce the labor outlay, should the cost of rice fall, than if the wages were increased.

Blending Casinghead Gasoline and Naphtha

A new edition has been prepared of the chart for blending casinghead gasoline and naphtha, computed by Clarence Netzen for the Bureau of Mines, Department of the Interior. This chart provides an easy method of determining the amount of naphtha to be used per gallon of casinghead gasoline to obtain a product of any required gravity. A copy of this chart will be sent on application to the Bureau of Mines, Washington, D. C.

Dr. F. G. Cottrell Succeeds Dr. Manning as Director, Bureau of Mines

THE resignation of Van H. Manning as director of the Bureau of Mines was not unexpected. It has been an open secret for several months that he would be selected as director of the research work of the American Petroleum Institute. Since it became known that Dr. Manning was about to resign there has been some agitation for the filling of the place with a mining engineer. Despite the very generally expressed preference for a mining engineer, the announcement that Dr. Frederick G. Cottrell, a chemist, had been recommended for the place brought forth no opposition. Dr. Cottrell's high professional standing and the fact that he has been in such close touch with the mining industry for so many years assure him of every confidence on the part of the mining industry. Dr. Cottrell was born in Oakland, Cal., Jan. 10, 1877. He attended school in Oakland and matriculated at the University of California in 1892. As a university student he gave especial attention to science, particularly chemistry. After graduation, in 1896, with the degree of Bachelor of Science, he was a Le Conte fellow at the university in 1896-7 and taught chemistry at the Oakland High School in 1897-1900. Then he went to Europe, where in 1901 and 1902 he studied at the University of Berlin and the University of Leipzig, receiving from the latter the degrees of Master of Arts and Doctor of Philosophy, 1902. On his return to this country, in 1902, he was appointed instructor in physical chemistry at the University of California, and in 1906 was appointed assistant professor, holding this position until 1911. While at the university Dr. Cottrell's chief contributions to science were researches relating to the electrical precipitation of fume and fine particles suspended in the gases of smelter, blast-furnace or cement works flues, and he finally evolved what is known as the Cottrell process for this purpose. This invention was first utilized at the Selby smelter in California for removing fumes from the waste gases of a sulphuric acid plant at the smelter, thereby abating a nuisance that threatened to necessitate shutting down the works. Subsequently this electrical precipitation process was installed at other smelters to remove fume and solid particles contained in the escaping gases, and it was also successfully used at cement plants, notably near Riverside, Cal., to prevent the dust from the calcining kilns from damaging nearby orange groves and vegetation.

DR. FREDERICK G. COTTRELL

Today the Cottrell process of fume and dust removal is in world-wide use, and is recovering materials heretofore wasted to the value of many thousands of dollars. One of the latest installations is at a large smelting plant in Japan; while the largest installation is at the Anaconda smelter, Anaconda, Mont. Dr. Cottrell in a desire to encourage scientific research turned over his extensive patent rights to a non-dividend-paying corporation, known as the Research Corporation, a body formed for that purpose. A fundamental requirement in the incorporation is that all net profits shall be devoted to the interests of scientific research.

In 1911 when Dr. J. A. Holmes, the first director of the Bureau of Mines, was serving as a member of commissions appointed by the Government to study alleged damages from smoke and fumes from the Selby and the Anaconda smelters, and when the Bureau of Mines was investigating at length the smelter-smoke problem, Dr. Cottrell, because of his scientific attainments and his special knowledge of metallurgical problems, was appointed chief physical chemist in the Bureau. In 1914 he was appointed chief chemist, in 1916 chief metallurgist, and in 1919 assistant director. Aside from his work on smelter smoke Dr. Cottrell has been deeply interested in and intimately connected with work on the separation and purification of gases by liquefication and fractional distillation. During the World War and subsequently the development of the Norton or Bureau of Mines process for the recovery of helium from natural gas has been his special care, and it was chiefly through his efforts that a plant for recovering helium on a large scale for military aëronautics has been erected near Petrolia, Tex. Dr. Cottrell is a member of the American Chemical Society, the Mining and Metallurgical Society of America, the American Electrochemical Society and the American Institute of Mining and Metallurgical Engineers. He was awarded the Perkin Medal by the New York Section of the Society of Chemical Industry in 1919 in recognition of his work on electrical precipitation.

Dr. Manning Deplores Inadequate Compensation

In his letter of resignation Dr. Manning says:

"In leaving the Government service there comes to me, as it has over and over again, the thought that although this Government spends each year many millions of dollars in useful scientific work for the benefit of the whole people, the monetary recognition of its scientific and technical servants is not sufficient to enable them to continue in the service for the people.

"With the marvelous expansion of the industry in this country and the growing necessity of science to industry, the scientific bureaus have been utterly unable to hold their assistants against the competition of industry which is taking their highly trained men at salaries the Government does not pay or even approach. I feel very deeply that there ought to be more adequate compensation for the scientific and technical men in the Government service so that none of them may be compelled to accept positions on the outside. Many of these scientific men are of fine type for Government work, care little for the commercial field, take an intense professional interest in their tasks and are of inestimable value to the Government."

Pre-War Legislation Affecting Nitrate Plants

Facts Concerning Political Activities in Congress—du Pont Co. Versus American Cyanamid Co.—Debate in the House and Senate—Passage of Measure as Section of National Defense Act—Selection of Site and Process—U. S. Nitrate Plant No. 1

BY CHESTER H. JONES

A CAREFUL review of the *Congressional Record* covering the 64th and 65th Congresses beginning March 15, 1916, and of the more recent testimony delivered before the Graham House committee, 66th Congress, answers many of the questions which have arisen concerning the political motives behind the nitrate situation, and causes new queries to arise in the mind of the investigator. Some of these must for the time being remain unanswered.

Nitrogen fixation from the beginning was linked with the idea of water-power development, probably because cheap power was found to be essential to the success of the arc process in Europe. The cyanamide process also required a considerable quantity of power. It is a singular fact, however, that not a pound of nitrogen was fixed by water power in the United States during the war period. Indeed, plans were consummated to operate the large plant at Muscle Shoals entirely by steam power, and for this purpose the steam plants on the Warrior River (30,000 kw.) and the equipment at the cyanamide plant (60,000 kw.) were installed by the Government, together with an eighty-mile transmission line. The work on the Wilson dam was temporarily abandoned. It is now considered essential to complete the dam in order to make the process plant a commercial success.

In his recent testimony before the Graham House committee, Frank S. Washburn, president of the American Cyanamid Co., said that he was first interested in water-power development in the Southern district and therefore went abroad in 1907 to find an industry which would be a large consumer of power, thus building up the load on his proposed power plants. He returned with the cyanamide process for nitrogen fixation, but was forced to install his plant at Niagara Falls on the Canadian side because of political conditions unfavorable to the release of water-power sites in the United States.

DU PONT PROPOSALS

The main controversy over nitrogen fixation opened in the Senate March 30, 1916, when Willard Saulsbury (Delaware) introduced bill S. 5,136 together with letters addressed to the Secretary of War and himself by Pierre S. du Pont, president of E. I. du Pont de Nemours & Co. These letters and bill contained a proposal whereby the du Pont company stood ready to negotiate a contract with the Government under which it would begin at once to construct a fixation plant in units of such magnitude as might be agreed upon by the Government, and the du Pont company would furnish the capital.

All the company asked was the release of water-power sites for the purpose. The bill provided "that at all times upon request of the Secretary of War the grantee shall deliver to the United States for military or naval purposes all or any part of the output of nitric acid at a price which shall include such profit as the Secretary of War shall determine to be reasonable, and his determination of the reasonableness of such profit shall be final."

An impartial study of the text of this bill and the accompanying letters discloses no ulterior motives such as were subsequently hinted at by political factions. The proposition seems clearly outlined and open. It was made by a reputable concern familiar with the Government methods of doing business.

Previous to the introduction of the above bill E. D. Smith (South Carolina) had introduced bill S. 4,971, which was at this time being considered by the Senate Committee on Agriculture. The committee had amended and was about ready to return it to the Senate. The Smith bill provided that the Government furnish the capital to build the necessary fixation plants. Upon the presentation of the du Pont bill, William S. Kenyon (Iowa) immediately recommended that the two bills be published side by side in the *Congressional Record*, and this was done.

SUPPORT OF THE SMITH BILL

Oscar W. Underwood (Alabama) called attention to the fact that the du Pont company was a private corporation and spoke at great length against private ownership. He called attention to President Taft's veto of the Coosa River project, which had forced the American Cyanamid Co. to build in Canada some years previously. "Next to defending the country against a foreign enemy," he said, "the development of the agricultural interests is most important." He introduced clippings from the newspapers in which the du Pont company was criticized, and read into the *Record* an article by Frank S. Washburn, "one of the great engineers of this country." Mr. Washburn's paper appears on page 5,153 of the *Congressional Record*, 64th Congress. Mr. Underwood was the chief speaker for the advancement of the American Cyanamid Co.'s interests throughout the controversy, as evidenced by this and subsequent speeches.

Mr. Smith (South Carolina) urged that his bill be acted upon. He quoted Mr. Washburn, president of the American Cyanamid Co., as to the practicability of the cyanamide process, and said the Committee on Agriculture had interviewed Mr. Washburn and found he practically controlled the patents on manufacture by this method.

OPPOSITION TO THE SMITH BILL

Thomas W. Hardwick (Georgia) opposed Government ownership as outlined in the bill, calling the whole procedure "socialism." He continued in this attitude as a matter of principle in all his subsequent speeches.

Henry C. Lodge (Massachusetts) spoke in part as follows:

"The argument is not whether a corporation is back of a certain movement or not. I suppose a corporation is wicked in Pennsylvania or Delaware and good in Alabama. We should know who is behind these propositions.

"Frank S. Washburn is a patriot, no doubt, but it occurred to me we might find out what his business interests are. It appears in Moody's Manual that he is president of the American Cyanamid Co., which has been manufacturing this fertilizer for some years; that he is a director of the Alabama Traction, Light & Power Co., once president of the Muscle Shoals Hydro-electric Power Co., and other companies which control nearly all the water powers in Alabama.

"Mr. Washburn is associated with James B. Duke, tobacco manufacturer, and through Mr. Duke the American Cyanamid Co. controls the Ammo-Phos Co. of New York, the Amalgamated Phosphate Co. and the Virginia Chemical Co., which companies in turn practically control the fertilizer and cottonseed oil business of the territory east of the Mississippi and large water-power interests in North and South Carolina.[1]

"This development was proposed as early as January, 1909. Now I have given [these details] at somewhat tedious length because they all seem to be connected with Mr. Washburn, whose pamphlet has been sent to us to give the facts in the nitrogen case."

Mr. Kenyon (Iowa) suggested an investigation of the various processes for nitrogen fixation. He showed J. W. Worthington's political activities in Florence, Ala., on the Muscle Shoals development and his corporation connections with Mr. Washburn. The Engineers Corps had previously made an estimate of $18,500,000 for a dam at Muscle Shoals, exclusive of equipment. The Government had granted Mr. Washburn a monopoly through his patents, over 100 claims being allowed. On March 16 and 17 he had admitted before the Committee on Agriculture that he and Worthington had worked in the interest of the bill. "We might as well write Muscle Shoals in the bill and be done with it," said Mr. Kenyon.

Underwood Amendment

Mr. Underwood replied to these criticisms in a long speech (page 5,647, *Congressional Record*). He referred to Mr. Washburn as "a great hydro-electric engineer, a man of great ability," and asked for the support of the Smith bill. In a later speech, April 12, 1916, he offered an amendment authorizing and directing the Secretary of War to make contract with the owners for the use, rental, lease or purchase of a suitable air nitrogen process and further authorizing him to lease the plant for fertilizer manufacture in peace time.

Mr. Hardwick (Georgia) spoke at length, calling Mr. Underwood a "socialist," upon which the latter replied that his purpose was to make nitric acid and not fertilizer.

The debate was continued over a period of three days, during which time evidence was submitted on both sides by various Senators. Dr. Leo Baekeland's article on nitrogen was printed in the *Record*. The opposition led by Mr. Kenyon (Iowa) argued against the amendment.

Mr. Kenyon said: "The Underwood amendment if it is adopted will provide for the Government furnishing the money and building the plant, then leasing it to private parties. I cannot vote for this amendment nor the bill to which it is attached."

Mr. Lodge urged against placing so much power in Mr. Washburn's hands.

The amendment was finally rejected on vote.

Disposal of the Smith Bill

During the later discussions on the Smith bill it was shown that the constitutionality of such legislation might be in question on the ground of Government ownership in peace time. The bill was indefinitely postponed at the close of the 64th Congress, Third Session. This document was, however, so similar to the measure which finally passed that the discussion on the whole subject was not reopened on the later issue. The foregoing therefore represents the attitude of those concerned with nitrogen fixation in the Senate.

Debate in the Lower House

The controversy in the House of Representatives appears to have been opened March 17, 1916, when James Frear (Wisconsin) called attention to the clause in an Army bill which authorized the erection of nitric plants. He said: "Why was this slipped into the Army bill after it had been proposed in the Navy bill, authorizing the expenditure of $24,000,000 in Alabama Power Co. holdings? Apparently the Government is being used to finance this company's projects. It is a five-line section costing the Government over $4,000,000 per line. Why give $24,000,000 to Mr. Washburn's experiment?" He quoted L. L. Somers, C. W. Bennett, Joseph W. Richards and other experts who differed with Mr. Washburn's statements on the cyanamide process. He further found that 58 per cent of the American Cyanamid Co.'s assets were propaganda and patent rights, as shown by the 1914 report of the company as follows:

Total assets	$6,563,510
License, patents and patent rights	3,569,578
Founding and propaganda	230,589

Mr. Frear continued: "The Duke interests are reported to control the best phosphate deposits of the country and, connected with Washburn, make a promising fertilizer monopoly. This is the old Muscle Shoals project in a new garb. The Alabama Power Co. owns parcels of land along the river. This section should be stricken from the bill." Five exhibits were presented (page 4,324, *Congressional Record*) showing the Alabama Power Co. and Duke activities, in the newspaper clippings.

Nitrate Section in the National Defense Act

The important legislation in the House was contained in H.R. 12,766, Sec. 124, referring to the establishment of Government-owned nitrate plants. This section was essentially the same as the Smith bill in the Senate except it provided for the delegation of authority to the President instead of the Secretary of War. During the discussion Mr. Lenroot (Wisconsin) suggested that it be amended to give the power of its administration to the Secretary of War. Mr. Foster (Illinois) spoke in favor of Government-owned nitrate plants and was supported by Tribble (Georgia) and Sherley (Kentucky).

Mr. Ferris (Oklahoma) said on May 8, 1916: "Du Pont and other ammunition companies are meddling too much in the Government affairs. I am in favor of the Government-owned plant. The Senate amendment (Un-

[1] See p. 5,641 of the *Congressional Record*, 64th Congress, for details of all these interlocking interests in the fertilizer industry.

derwood amendment to Smith bill) will give all the surplus power to the American Cyanamid Co., and they in turn will sell it to the farmer at their own sweet price."

Mr. Miller (Delaware) defended the du Pont position. Other members of the House spoke in support of the nitrate provision, with Mr. Hulbert (New York), who demanded public hearings on the facts before the money was expended.

National Defense Bill Becomes a Law

The nitrate provision was finally carried through in Sec. 124, H.R. 12,766, National Defense, and became a law June 3, 1916, as recorded on page 215, vol. 39, part 1, Public Laws. Public 85. It reads as follows:

> Sec. 124. *Nitrate Supply.*—The President of the United States is hereby authorized and empowered to make, or cause to be made, such investigation as in his judgment is necessary to determine the best, cheapest and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products by water power or any other power as in his judgment is best and cheapest to use and is hereby authorized and empowered to designate for the exclusive use of the United States if in his judgment such means is best and cheapest, such site or sites, upon any navigable or non-navigable river or rivers or upon the public lands as in his opinion will be necessary for carrying out the purpose of this act; and it is further authorized to construct, maintain and operate, at or on any site or sites so designated, dams, locks, improvements to navigation, power houses and other plants and equipment or other means than water power as in his judgment is best and cheapest, necessary or convenient, for the generation of electrical or other power and for production of nitrates or other products needed for munitions of war and useful in the manufacture of fertilizers and other useful products.
>
> The President is authorized to lease, purchase or acquire, by condemnation, gift, grant or devise, such lands and rights of way as may be necessary for the construction and operation of such plants and to take from any lands of the United States or to purchase or acquire by condemnation materials, minerals and processes, patented or otherwise, necessary for the construction and operation of such plants and for the manufacture of such products.
>
> The products of such plants shall be used by the President for military and naval purposes to the extent that he may deem necessary, and any surplus which he shall determine is not required shall be sold and disposed of by him under such regulations as he may prescribe.
>
> The President is hereby authorized and empowered to employ such officers, agents or agencies as may be in his discretion necessary to enable him to carry out the purposes herein specified, and to authorize and require such officers, agents or agencies to perform any and all the duties imposed upon him by the provisions thereof.
>
> The sum of $20,000,000 is hereby appropriated, out of any moneys in the Treasury not otherwise appropriated, available until expended, to enable the President of the United States to carry out the purposes herein provided for.
>
> The plant or plants provided for under this act shall be constructed and operated solely by the Government and not in conjunction with any other industry or enterprise carried on by private capital.
>
> In order to raise the moneys appropriated by this act and necessary to carry its provisions into effect, the Secretary of the Treasury, upon request of the President of the United States, may issue and sell, or use for such purpose or construction, hereinabove authorized, any of the bonds of the United States now available in the Treasury of the United States, under the act of Aug. 5, 1909, the act of Feb. 4, 1910, and the act of March 2, 1911, relating to the issue of bonds for the Panama Canal to a total amount not to exceed $20,000,000: *Provided*, that any Panama Canal bonds issued and sold or used under the provisions of this section may be made payable at such time after issue as the Secretary of the Treasury, in his discretion, may deem advisable, and fix instead of fifty years after date of issue as is said in the act of Aug. 5, 1909, not exceeding fifty years.

In spite of all the opposition, and with all the evidence presented which questioned the motives of its supporters, the nitrate measure became a law. Its passage through Congress was facilitated by the immediate necessity for national preparedness, by the fact that it was of Democratic origin and that the promoters held the control of the only process which was commercially successful in this country at that time. A complete review of all the legislation on the subject is available in the testimony of George Walter Johnson before the Graham House committee published in the hearings Serial 6, Part 50, Jan. 2, 1920, beginning on page 2,537.

Selection of Site

Newton Baker testified that shortly after the act was passed, with its provision for an investigation of sources of power and processes of manufacture, the President appointed the Secretary of the Interior, the Secretary of Agriculture and the Secretary of War as a delegation to go about through the South and see where a proper site could be found for the building of a plant for the production of nitrates in war time and fertilizer in peace time. This trip was made in March, 1917, in company with a party of nitrogen-fixation experts, including Colonel Wheeler and Dr. Charles L. Parsons. They visited points in Tennessee, Kentucky and West Virginia. They never visited Western points, but intended to do so.

Some time after the return from this trip the three Secretaries discussed the matter informally, and Mr. Baker talked it over with the Chief of Engineers and the Chief of Ordnance. The latter, supported by other members of the party, submitted the following recommendations:

> I think that the examinations made indicate the limit of choice to four localities, viz.: Chattanooga, Knoxville, Sheffield and North Birmingham, and after fully considering all the aspects of the matter, it is my opinion that the site at North Chattanooga, Tenn., having been adjudged first from the fertilizer standpoint and next from the compromise standpoint, is best fitted for the constructions now contemplated, and I recommend its adoption, and the purchase of a tract of 500 to 600 acres.
>
> William Crozier,
> Brigadier General, Chief of Ordnance, United States Army.

On the margin of that memorandum dated Aug. 6, 1917, is a postscript, or a sort of note:

> The original letter 471, 86/2020—Nitrogen, j/z. dated Sept. 20, 1917, a memorandum for the Secretary of War, signed by William Crozier, Brigadier General, Chief of Ordnance, United States Army, copy of which you already have been furnished; bears the following postscript in long-hand:
>
> "The President has selected Sheffield. So informed by Secretary of War.
> 9/28. W. C."

It is understood that the department heads indorsed this recommendation to the President, but he decided on the Sheffield, or Muscle Shoals, location in spite of such advice. The authority was vested in the President according to the provisions of the law, and he was evidently persuaded by advisers not members of the delegation which had been charged with recommending a proper site.

Selection of the Process

During the time that the site was under discussion, the committee of the National Academy of Science was

investigating the matter of processes, having made a trip to Europe for the purpose. Other commissions and individuals were carrying on similar inquiries.

Appointed by General Crozier to visit Europe in 1916, Dr. Charles L. Parsons studied processes in England, France, Italy and Greece and made an individual report which did not agree with the report made by the National Academy committee, in that he strongly favored the synthetic ammonia or modified Haber process of the General Chemical Co.

The Secretary of War then appointed a new committee called the Nitrate Supply Committee, and made Dr. Parsons a member. The personnel of this committee was as follows:

General William Crozier, Chief of Ordinance, U. S. Army; Admiral Ralph Earle, U. S. Navy; General William Black, Chief of Engineers, U. S. Army; F. W. Brown, U. S. Dept. of Agriculture; Dr. Leo H. Baekeland, Gano Dunn, Dr. Charles H. Herty, Dr. William F. Hillebrand, U. S. Bureau of Standards; Dr. Arthur A. Noyes, Dr. Charles L. Parsons, Dr. Willis R. Whitney.

This committee recommended, among other things, that the Government negotiate with the General Chemical Co. for the right to use the synthetic process for making ammonia, erect a plant to produce thirty tons of ammonia per day and an auxiliary plant to oxidize the ammonia to nitric acid.

U. S. Nitrate Plant No. 1

Contract was made with the General Chemical Co. as advisory engineer, on the modified Haber process, with the J. G. White Engineering Corporation as construction engineer to undertake the erection of the plant and with the Chemical Construction Co. to construct the special apparatus in the nitric acid plant. Thus the work on U. S. Nitrate Plant No. 1 at Sheffield, Ala., was finally started, during August, 1917.

Political Comment

On Sept. 14, 1917, Nicholas Longworth (Ohio) spoke in the House of Representatives concerning the report of the Nitrate Supply Committee mentioned above, quoting Dr. Herty as stating, "The country will receive supplies of fixed nitrogen far more quickly than possible under the methods which would require time in the development of water power." Mr. Longworth adds: "I was opposed to the $20,000,000 nitrate scheme because it involved only one plant. On report of Dr. Parsons, General Crozier and others it has been decided to indefinitely postpone making nitrogen by water power. This, thank goodness, sounds the death knell of the Muscle Shoals nitrate scheme. Its abettors and supporters have been knocking at the doors of Congress for some years."

Conclusion

It is not within the scope of this article to give more than a brief outline or series of sidelights from the history of the circumstances surrounding so wide a subject. Many inferences may be drawn from thorough research in the available archives to suit the taste of the individual explorer. No one can deny that with the present knowledge of the case at hand many humorous things are to be found in so reviewing.

It is the story of political intrigue, with the ever-present private interests in the near background; of sectional preference, with the needs of the nation often a secondary consideration, and differences of opinion held by scientists on a comparatively new subject. It may be gathered from the above paragraphs that Mr. Underwood is the gentleman from Alabama who helped do things for his state; that Mr. Longworth is from Ohio, not Alabama; that Mr. Washburn is in the fertilizer business; that Dr. Parsons is a strong advocate of the synthetic ammonia process; that the President ignored his official advisers, and many other pertinent facts which will make the readers of Chemical & Metallurgical Engineering better acquainted with the gentlemen who will have something to say when the pending bills for the operation of the Government plants are returned to Congress from the committees.

In the days of the war when these things were carried on, there was no question as to the earnest effort of the principals to accomplish those objects which would be of greatest benefit to the nation. Beneath it all lay a sound economic theme, and because the country needed nitrates in war and peace alike the deed was consummated. Because of patriotic fervor it was done quickly and successfully. The equipment stands idle today awaiting the action of Congress to start its operation in the service of agriculture.

Use of Cibucao Wood for Dye in Hongkong

The business of the import of "cibucao" wood from the Philippines and its manufacture into a stain or dye in Hongkong is in the control of a close combination of five Chinese firms in Hongkong, of which Yuet Loong Chan & Co., Hongkong, is the principal. The wood, called "Soo Mook" in Chinese, comes almost exclusively from Iloilo and vicinity in the Philippines. It is a red, fairly soft wood, and is cut and cured in short lengths and imported in bundles. It is bought and sold by the picul (133⅓ lb.), its price in Hongkong at the present time being about $2.10 local currency, or substantially the same in gold, per picul. The stain or dye manufactured from the wood is a red ink or paste used largely by the Chinese for inking the small "chops" or seals employed by them as the means of affixing their signatures to written instruments of a formal nature.

The color in the wood is extracted and used variously by the Chinese as an ink, a stain, dye, and paint color. The wood is boiled and the resulting water solution is further boiled down to a siruplike consistency. Whiting is then mixed with it for most purposes, the resulting paste being the preparation used as an ink for the native "chops." As a dye the stain is used for coloring cheap Chinese papers, notably the paper used in the manufacture of firecrackers, ceremonial papers of various sorts, and for the very cheapest sort of Chinese stationery. The whiting concentrate also is used as an adulterant for European red paints. The color liquor also is used at times for mixing with better quality of red dyes for coloring native cloths.

The whole process of extracting the dye is crude and wasteful, but the business is closely controlled by this syndicate, which is strong enough to regulate the volume of the manufacture and the price of the product. It is doubtful, therefore, whether it would be practicable to transfer the industry to the Philippines and have the dye or stain manufactured there for sale in China, although apparently there would be a considerable saving in freight and other expenses by so doing.

A Comparative Test Upon High-Speed Steels—II

Conditions Entering Into the Testing of a Tool for Cutting, Listed by Taylor, Are Discussed—Detailed Information is Given as to the Method of Eliminating Most of the Variables From a Comparative Test for the Efficiency of Several Brands of Commercial Tool Steel*

By A. J. LANGHAMMER, M.E.†

As EVERYONE knows, the Packard Motor Car Co. was the pioneer manufacturer of Liberty airplane motors for the United States Government during the war. In building Liberty "12" airplane motors, one of the most intricate problems was that of machining the steel cylinders. At the start of the manufacturing program, this unit was made of a solid billet, which practice fortunately was rendered obsolete by the most opportune invention of the Ford Motor Co. The Ford method permitted the making of these cylinders from steel tubing at greatly reduced initial cost and with an additional huge saving in labor (boring of billet) and tool costs. The material used was heat-treated mild carbon steel, subjected to rigid Government inspection for both composition and physical properties before it entered the machine shop. The result was, therefore, a product of unusual uniformity, thereby furnishing a material of exceptional merit for testing purposes. Since it was not only essential to get a product of highest quality machined to extremely low tolerance and limits but it was also vital to obtain a maximum production of airplane engines, a test was decided upon to determine the high-speed steel which would meet these difficult requirements. The following pages describe that test in detail.

Elements Entering Into the Cutting of Metal

Dr. F. W. Taylor in his "Art of Cutting Metals" gives twelve elements that affect the cutting speed of tools. To this must be added one more, the human element, thoroughly recognized by Dr. Taylor but emphasized by Prof. A. L. Jenkins, professor of mechanical engineering at the University of Cincinnati. As every test of cutting tools that is to be of any value must take full cognizance of these elements, they are listed below in abbreviated form:

1. Quality of metal to be cut.
2. Chemical composition of the tool steel and its heat treatment.
3. Thickness of shaving (feed per revolution).
4. Shape or contour of cutting edge of tool.
5. Type of coolant (water, oil) used.
6. Depth of cut.
7. Duration or length of cut.
8. Lip and clearance angles.
9. Elasticity of the work and of the tool, i.e., degree of chattering.
10. Diameter of work.
11. The changes of speed and feed possible in the machine tool.
12. The pulling and feeding power of the machine tool.
13. Human element.

To simplify the test and make the results more positive, as many elements as possible were made constant. Each variable as it affected our test in accordance with the above classifications will be discussed briefly.

Cutting Speed

In determining the proper cutting speed,[1] the depth of cut, feed, and the machine tool flexibilities had to be considered most carefully. The depth of cut was first determined (see discussion under that heading below) and then with the aid of special tools, not included in the test proper, several runs were made and a cutting speed of 35 ft. finally chosen. This value was used throughout the test in all runs and was maintained at a constant value, thereby eliminating the factor "cutting speed" as a variable.

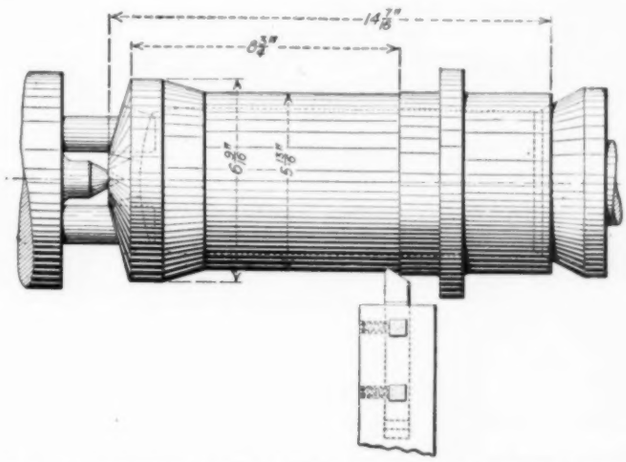


FIG. 1. SHOWING THE MATERIAL CUT AND SET-UP USED IN TESTS

Quality of Metal to Be Cut

The metal cut was the Liberty airplane motor cylinder, a mild carbon (0.40 to 0.50 per cent) heat-treated stock. Fig. 1 shows the cylinder in the rough before any machining operations have been performed. Every cylinder used in the test had to show a hardness between 217 to 255 Brinell (scleroscope 36 to 43) before it was accepted by Government inspectors. As there were thousands of cylinders to choose from, only those were actually selected for test purposes whose scleroscope range did not exceed these points. Each cylinder was also carefully inspected for out-of-round, eccentricity, variations in diameter, fins, and excessive scales or rust formations, any unsatisfactory specimen being summarily rejected. Attention is invited to these exceptional conditions by which the test was favored because such a desirable material would hardly be found avail-

*For Part I see CHEM. & MET. ENG., vol. 22, No. 18, May 5, 1920, p. 829.

†Industrial engineer, Thompson & Black, engineers and accountants, New York and Detroit.
Formerly mechanical engineer, Packard Motor Car Co.

[1]See "Art of Cutting Metals," F. W. Taylor.

TABLE II. COMPOSITION AND HEAT TREATMENTS OF TOOL STEELS TESTED

	Chemical Composition *							Heat Treatment				
Brand	Carbon	Tungsten	Vanadium	Nickel	Chromium	Cobalt	Uranium	Preheating	Hardening	Quenching Medium	Drawing Temperature	Remarks on Heat Treatment
A	0.79	12.8	1.74	0.10	3.78	None	None	All tools slowly preheated to 1550-1600 F.	The temperature in the hardening furnace was maintained at practically 2300 F. The tools were withdrawn and quenched when the condition of sweating was satisfactory to the expert representing the steel company which produced the brand being hardened.	Oil	1050	Cyanide on tip of tools during hardening.
B	0.64	16.9	0.92	0.10	2.42	None	None			Lead at 1050 F.	1100	"B" tools withstood the high heat very well.
C	0.40	18.00	0.51	Tr.	3.53	None	0.11			Lead and kerosene.	1050	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in kerosene
D	0.62	14.86	1.05	Tr.	3.59	None	0.10			Lead at 1050 F.	1100	One-half of tool immersed in lead. Relatively short heat.
E	0.49	17.35	0.23	Tr.	2.78	None	0.14			Lead	1100	
F †	0.67	19.70	0.99	0.21	3.78	None	None			Oil and lead	1100	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in oil.
"	0.65	15.79	0.49	0.24	3.44	None	None					
G	0.62	18.25	0.75	Tr.	3.70	None	None			Oil	1050	
H	0.66	18.30	0.45	None	4.17	None	None			Lead at 1050 F.	1075	
J	0.68	18.12	0.48	Tr.	2.63	None	0.10			Oil and lead	1050	Tools 0 and 3 were immersed half way in oil; then they were placed on the floor and thus drawn.
K	0.59	13.34	0.95	Tr.	3.64	None	0.15			Oil	1075	
L	0.76	21.92	1.05	None	5.27	None	None			Lead at 1050 F.	1050	
M	0.69	16.95	0.75	0.18	3.09	None	None			Oil and kerosene	1100	Tool 2 quenched in oil. Tools 0, 1 and 3 quenched in kerosene. "M" tools withstood the high heat very well.
N	0.66	13.55	2.20	0.10	3.59	None	None			Oil	1050	
O	0.67	13.50	0.99	0.20	4.30	None	None			Oil and lead	1100	For tool 0 only. Tools 1, 2 and 3 were not drawn.
P	0.38	15.27	0.05	0.20	2.85	None	0.14			Lead	1100	Blistered on heating.
R	0.65	17.08	0.58	0.20	2.78	None	0.10			Oil and lead	1075	Tools 0 and 2 were quenched in lead. Tools 1 and 3 were quenched in oil.
‡	0.75	11.12	2.10	0.32	5.13	None	None				None	

The samples for chemical analysis were obtained from the same section of the bar of which the tools were made.

The temperature of the lead bath used in quenching was maintained at a temperature of 1050 F. The tools were immersed in the molten metal for about 3 min., and then allowed to cool in the air.

* Phosphorus and sulphur below 0.04 per cent in all cases.

† The second analysis under F gives that of a second bar obtained subsequently.

‡ This steel was not tested, but its microstructure is shown in Figs. 13 and 14.

able in ordinary practice. The factor of "quality of metal to be cut" was perforce a constant.

As a matter of record the metal being cut may be noted to be the so-called "Aircraft Standard Steel," or S.A.E. 1045, known to the trade as 0.45 carbon machine steel. The chemical compositon is

	Per Cent
Carbon	0.40 to 0.50 (0.45 desired)
Manganese	0.50 to 0.80 (0.65 desired)
Phosphorus	0.045 maximum
Sulphur	0.05 maximum

Ordinary heat treatment given the forgings consisted of a quenching in oil or water from 1,500 to 1,550 deg. F. (820 to 845 deg. C.) and a drawing at 1,150 to 1,200 deg. F. (620 to 650 deg. C.).

After such treatment the physical properties were:

Elastic limit (approximately)	67,000 lb. per sq.in.
Tensile strength (approximately)	98,000 lb. per sq.in.
Elongation	20 per cent
Reduction of area	56 per cent

Chemical Composition of the Tool Steel and Its Heat Treatment

In the first few columns of Table II are given the chemical composition of each set of tools of the separate brands, as determined by actual analysis. This composition supposedly represented the standard practice of the steel manufacturer. If the company made more than one grade of high-speed steel, the best or "superior" grade only was specified, as will be pointed out in more detail in the next paper. The heat treatment of each tool likewise is shown in Table II. "Chemical composition" therefore was a variable.

Thickness of Shaving

Experience has taught that the finer feeds are not adapted to test work because slight imperfections either in the cutting edge of the tool or in the material cut affect the tool in a manner more disastrous than a coarse feed. In shop practice, too, medium or heavy feeds are generally used and if the test conditions approach normal practice the results can be more easily interpreted by shop men. A feed of 0.054 in. was used in our "first run" and 0.090 in. in the "second run." (See discussion below under "Methods of Procedure.") As each value of feed was adhered to throughout the individual runs the "thickness of shaving" was a constant.

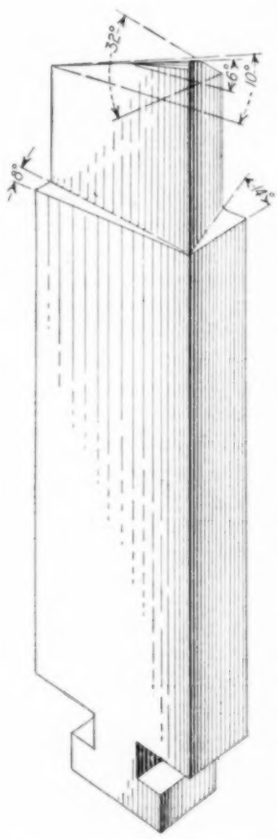


FIG. 2. LO-SWING LATHE TURNING TOOL

Shape or Contour of Cutting Edge of Tool

Fig. 2 shows the type of tool used in the test. Each individual tool was machined, rough ground and finish-ground. This particular design of tool is adaptable for a "Lo-Swing Lathe," because on such a machine the cut is generally started by "feeding in" the tool to the desired depth and then engaging the feed, rather than "setting" the tool to the desired depth before engaging the power feed. (See Fig. 1 for the illustration of this point.) Also on most work a "gang" of tools are used, some of which must cut right up to a shoulder or flange, necessitating the side cutting edge of the tool being parallel with the shank. All grinding was performed by an expert on a Taylor automatic tool grinder and every tool was inspected after the final operation.

A nose of $\frac{1}{16}$ in. radius or $\frac{1}{8}$ in. "rounding" was ground on all tools for the first run, while a $\frac{1}{4}$-in. radius or $\frac{1}{2}$-in. "rounding" was adopted during the second run. The radius was increased during the second run, because with the given designs of tool this procedure necessitated the minimum grinding and thereby reduced the chances of harming the tool during the grinding operation. As the stated values of the radii were uniform

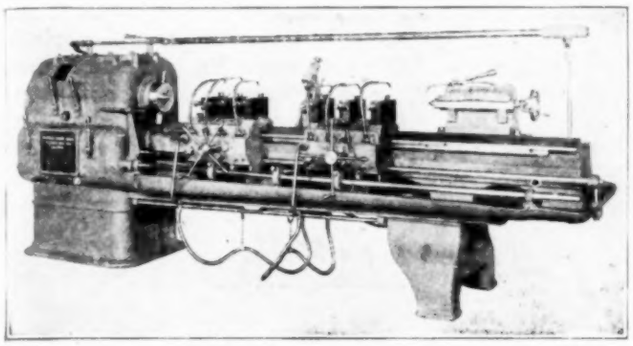


FIG. 3. TYPE OF MACHINE TOOL USED IN TESTS. EIGHT-INCH LO-SWING LATHE

for each run and the shape of the tool was rigidly inspected after grinding, the "shape or contour of cutting edge of the tool" was made constant.

Type of Coolant or Cutting Compound

The use of a coolant in itself introduces several variables (such as uniformity of material, pump trouble, misguidance of the cooling stream, etc.), adds considerably more work, and provides for possible inaccuracies. As it was desired to determine only the comparative life and not the maximum attainable, no coolant was used, thus making this factor, "type of coolant or cutting compound," zero.

Depth of Cut

Once either the feed or the depth of the cut has been decided upon, the other factor in conjunction with the cutting speed is determined by the time limit set for failure to occur, and by the power and flexibility of the machine tool employed. In this case the depth of cut was established first, because the material cut had to enter the regular production when the machine work was finished. This, then, limited the diameter to which the specimen could be reduced, and thereby automatically established the depth of cut, $\frac{3}{32}$ in. in this instance. The value of the depth of cut, like the feed, should in all cases approach the normal for ease of interpretation, and the figure stated checks very closely with the amount of stock removed in the average roughing operation on a simple drop forging. A snap or external limit gage that held the turned diameter to a variation of 0.005 in. was used to measure the depth of cut (the rough diameter of the material had been previously checked, as already described at length under "Quality of Metal to Be Cut"), so that the "depth of cut" was reduced to a constant.

Duration or Length of Cut

The duration of cut in a test on cutting tools is an item that requires very careful consideration. When too short a time limit is chosen, the results are questionable, if not valueless, because the heat generated at the working point of the tool is so great as to cause unjustifiable and wide variations in duration of cut. Too long a time is somewhat less objectionable, because it entails increased difficulties with respect to securing homogeneous material and possibly induces general inaccuracy. Therefore, for the first run, a duration of about 25 per cent less than the standard practice on that particular class of work was chosen. On the second run, however, a value which caused an average good tool (as determined by experiment with tools made up especially for this purpose) to fail within 20 min. was applied. Of course the time limit, other things being equal, depends on the cutting speed, feed, and depth of cut. As the depth of cut was predetermined due to the fact that the material used was a "production part" and the feeds and speeds of the machine tool used, an 8-in. Lo-Swing Lathe, Fig. 3, were limited, it was decided to change the feed only to vary our duration or length of cut. The element of "duration or length of cut" was perforce a variable.

Lip and Clearance Angles

At the beginning of the test the design of tool and all clearance angles were decided upon. The various clearances and slopes were as follows: 6 deg. clearance at the nose and 10 deg. clearance at the heel, 14 deg. side slope, no back slope, 32 deg. horizontal clearance, 8 deg. vertical clearance, 84 deg. lip angle and 90 deg. cutting angle. See Fig. 2 for a perspective representation of this tool and the values given. As these values were identical on each tool, the element of "lip and clearance angles" was of necessity a constant.

Elasticity of the Work and of the Tool, or Chattering

Chattering affects both the cutting-speed and finish of the work and is caused by incorrect design of cutting tool, incorrect method of clamping and driving the work, poor design and ill fits in the machine tool, synchronizing of the effects of defective elements and loose fittings in the machine and the set up, or a combination of these. By inspection of Fig. 2 it will be seen that the design of tool was such as would discourage chattering. In the same way Figs. 1 and 3 show an unusually rugged

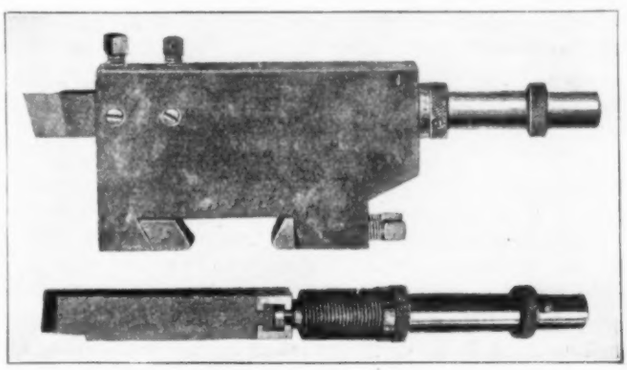


FIG. 4. DETAIL OF THE METHOD OF TOOL HOLDING, TOOL CLAMPING AND TOOL FEEDING

and positive drive with a good set up, so that chatter from this source was eliminated. Attention is invited to Fig. 4, which shows the particularly rugged tool block that was used. It is to be noticed that fully 80 per cent of the total length of the tool rests solidly on its base and that set screws are provided for securing absolute rigidity both horizontally and vertically. The choice of

machine tool provided a unit that was very adaptable to the work of the test, so that "chattering" as it affected the cut-speed was made a constant, approaching zero.

Diameter of Work

Under "Quality of Metal to Be Cut" it was pointed out above that all forgings were carefully inspected for variations in diameter. As a huge amount of stock was available, nothing but perfect specimens were accepted, so that the "diameter of work" was easily made a constant. This, too, was a feature that cannot easily be duplicated under ordinary conditions. Also the value of the diameter was such that it provided for easy interpretation in general shop practice.

Change of Speed and Feed Possible in the Machine Tool

In Fig. 3 is shown a half tone of the machine tool used in the test. The range of speeds and feeds are given in Table III.

TABLE III. CHARACTERISTICS OF MACHINE TOOLS USED

Spindle Speeds for 500 R.p.m. of Pulley	Feed per Revolution, Inches
25	0.166
45	0.120
75	0.090
120	0.054
200	0.040
325	0.030
	0.018
	0.013
	0.010

A belt- and not a motor-driven machine was used, so that the choice of feed and speed to secure failure of the tool within a given period was somewhat limited. By establishing the cut-speed and depth of cut at the onset, a proper feed was, however, readily determined so that the "change of speed and feed possible" was eliminated as a contending factor.

Pulling and Feeding Power of the Machine Tool

Inspection of Fig. 3 will show a lathe of rugged construction. The geared headstock is of good strength, and the heavy bed, carriage, and feed mechanism provide for rigid support and taking of heavy strains. As a matter of fact, the load applied in the test did not at any time approach the possible duty of the machine. The unit used was a new machine that had only been "limbered up" preparatory to the test. No variations were therefore introduced due to the "pulling and feeding power of the machine tool."

Human Element

It is generally conceded that in any undertaking the human element presents a very complex problem. This factor, therefore, received due attention and the personnel was made up not of one but of two operators who, in addition, were not only lathe hands but tool makers as well. Both men worked under constant supervision of a competent observer who was a technical graduate with years of practical experience. To further insure the accuracy of the test, other engineers checked the data and operations at frequent intervals so that the "human element" was made constant in so far as it was possible.

Variable Factors in the Tests

By a review of the above thirteen elements and the brief discussion of the manner in which they affected the test, it will be seen that only two—chemical composition of the tool, and duration or length of cut—remained variables. This condition, then, formed the basis of the test.

Duration of Test

Possibly it will occur to the reader to ask, "How long did it take to run this test?" To answer this the following data are submitted:

The time that elapsed from the date on which it was decided to run the test until the work was all completed and the data compiled was five months, in round figures. The actual number of cylinders turned with the test tools was 1,251 while another 150 were machined by special tools in determining the correct feed and duration of cut for the test proper. All told, then, 1,400 cylinders, or 1,690 ft. of 5¾-in. medium-carbon steel, were machined in this test.

(Part III will be published in our next issue.)

Belgian Penalties for Commercial Fraud

American manufacturers or exporters having trade disputes with Belgian importers should take note of the penal provisions of the Belgian code relating to obtaining money under false pretences. According to article 428 of the code, such false pretences connected with the sale of goods (*tromperie sur marchandises vendues*) are punishable by imprisonment of from one month to one year, or by fine of from 50 to 1,000 francs, or both. Fraudulent intent may arise from the furnishing of goods not of the quality or kind specified, or from deliberate failure to furnish specified quantities.

As *tromperie sur marchandises vendues* is a basis for criminal action, aggrieved Belgian importers have the right to cause the arrest of foreign vendors accused of such practices upon their arrival in Belgium. As there is no provision for release on bail pending trial in criminal cases, as in the United States, evidence of fradulent intent must be clearly shown by Belgian business men before a warrant is issued, however.

In a recent case a small and apparently irresponsible export house in New York had sold adulterated goods to several Belgian dealers. The importers had rejected the shipments when chemical analysis disclosed the adulteration and were attempting to secure reimbursement from the exporter. In the meantime one of the members of the exporting firm arrived in Brussels and was promptly threatened with summary arrest by his customers.

In this instance the export house claimed that the supplying manufacturer was responsible for the adulteration; it was also claimed that there was a misunderstanding regarding the nature and quantity of the goods, owing to ignorance of the French language. It was therefore impossible to establish prima facie fraud sufficient to justify imprisonment pending trial of the case. However, if the visitor to Belgium had been a manufacturer (not a forwarder) who had clearly furnished adulterated goods and received payment therefor, the result would no doubt have been more serious.

Polish Courts to Register American Firms

The Legation of Poland in Washington has received information from its government that courts in Poland have been instructed to register American firms without hindrance.

The Function of the Chemical Engineer in the Biscuit and Cracker Baking Industry

Application of Chemical and Industrial Engineering in the Baking Industry Is Now Recognized to Be a Really Great Step Toward Technical Improvements Leading to Uniformity of Products Manufactured and Efficiency of Plant Operation

By O. C. F. LIPPERT
Chemical Engineer, the George H. Strietmann's Sons Co.

THE idea of having a chemical engineer associated with the organization of a biscuit and cracker bakery is a modern one. This is due to the fact that biscuit and cracker bakeries until recently have been rather successfully conducted by the "rule of thumb" methods.

The industry for the most part was made up of very small units in which it was possible for one or two men to successfully make and bake all the products by a sort of intuition, just as the housewife supplies the home with good bread and cake. That is, if she is asked to tell how she makes her products, she will somewhere in her instructions for making, or in her recipe, say: "I add so much of this or that until I get a certain taste," or else she will say: "I bake it until it gets such and such a color."

In a similar manner in the past and to some extent even today, the foremen of the various departments had and have that intuition which permits them to turn out a product which cannot be readily duplicated, even by their own assistants.

Chemical Engineering Work Needed to Obtain Uniformity in Manufactured Products

When one of these small units reaches a certain size, it becomes necessary that the products which the firm produces maintain a certain standard. Unfortunately it becomes impossible to maintain this standard when the responsible foreman is incapacitated. This is disastrous to the marketing and sale of the product and so the slogan of the sales department is "Uniformity." In the home or smaller concerns the problem would be met by waiting until the return of the party with the "gifted or inspired method of procedure." Where the units or plants are large, it is readily admitted that this is entirely impractical. Accordingly it becomes necessary to devise means and methods to bring about this uniformity. In this connection the services of a chemical engineer are most valuable, as his training, devoted to the study of materials and to methods of manufacture, fits him for undertaking work of this nature.

His work almost automatically divides itself into three main divisions which may be characterized as studies of (*a*) raw materials, (*b*) methods of manufacture, (*c*) finished products and industrial engineering.

Raw Materials

The problem of studying raw materials as used in the baking industry with reference to uniformity is complex. There is probably no industry which uses so many varieties of raw materials in so many combinations. Also, the raw materials are, for the most part, organic in nature and complex in structure, as the following list will show: Flour, butter, lard, shorteners, vanilla and flavoring extracts, eggs, milk, sugar and others. The inorganic raw materials, such as salt, sodium bicarbonate, do not present any difficulties. However, ammonium carbonate, the associate of sodium bicarbonate as to functioning, has presented rather interesting studies from time to time owing to its complex nature.

Methods of Manufacture

Topics in this group are:

1. The proper sequence of raw materials in mixing.
2. The physical condition of the raw materials before mixing.
3. The manner of mixing.
4. The conditioning or aging of the mix.
5. The treatment or preparation of the dough for the cutting machine.
6. The quantity of heat used.
7. The quality of heat used (including kind and temperature).
8. The method of baking (whether directly on the ovenpans, or on wire mesh pans, or on separate greased pans).
9. The subsequent cooling of the product.
10. The time elapsed from leaving oven until in container.

Not every problem required a study of all of the above topics, but all required taking into consideration at least the greater number of them.

Finished Products and Industrial Engineering

Concomitant with methods of manufacture, problems of industrial engineering are met with such as:

1. Time and motion studies of operations.
2. Stock arrangements.
3. Routing of materials (both raw and finished).
4. Costs and production.
5. Mechanical problems of equipment.

Typical Analyses Needed in the Baking Industry

In order to give some idea as to the nature of the raw materials studies, the following is presented.

The main raw material used in the baking industry is flour, which is supplied in sacks of 98 lb. and 140 lb. (usually the latter). It is stored on platforms or trucks, twenty-one sacks to a platform in layers of three sacks each. The problem of getting representative samples and keeping track of the various lots as received and analyzed was rather annoying, as it was of little importance to the stores department workmen to keep supplies according to lots. It was met by tagging each platform with a serial number and using the well-known butter or lard "trier" or "thief." It was found that the

trier gave a conical sample extending from the outside of the sack to the inside or center. In this way, the sample contained flour which had been subjected to atmospheric conditions as well as flour which had been protected from same. By taking samples from several sacks in proportion to the size of the lot of flour and mixing these sack samples, a very representative lot sample was obtained.

The next problem was, What kind of analysis should the flour be subjected to, consistent with time, cost and results?

The following analyses are typical of flour as used in the baking industry and as submitted by wheat and flour-testing laboratories:

	Straight Per Cent	Patent Per Cent	Patent Per Cent
Moisture	12.50	11.18	11.70
Fat or oil	1.12	0.98	1.35
Ash	0.564	0.508	0.488
Absorption	57.00	56.00	56.55
Color	100.00	104.00	101.00
Gluten (dry)	8.38	9.49	10.36
Protein (5.7 × N)	9.22	10.28	11.55
Quality of gluten	100.00	94.70	101.50

Sometimes the additional information of loaf value (expressed in per cent) is given.

Critical Study of the Analyses for Use in the Cracker-Baking Industry

A critical study of the analyses for use in the cracker-baking industry as to the importance of the individual items, consistent with time, cost and results, led to the following conclusions:

1. That the moisture, gluten, absorption, protein and ash determinations were worth the time and cost.
2. That the fat determination was not worth the time and cost.
3. That the loaf value was not directly applicable in the cracker and cake industry and hence not worth the time consumed in obtaining it.
4. That the color and quality of gluten determinations were of some value.
5. That some supplemental test or determination would have to be made which would give the same information to the cracker baker about the quality of gluten that the loaf value does to the bread baker.
6. That this test must be carried out in conjunction with some of the other tests.

The bread baker bakes one kind of product—that is, he bakes different kinds of bread—but he is not using his flour in as many different formulas nor is he using it with as many kinds of ingredients.

Importance of Determining the Value of Gluten and the Method of Its Determination

The problem narrowed down to determining the value of gluten as gluten alone and the effect of heat on the gluten, i.e., of determining what was afterward called the expansion test.

At the present time no method is known by which proteins or gluten may be isolated by chemical methods. However, the physical method, of washing out the starchy part of flour, is very applicable, especially so since it can be carried out with rapidity. Furthermore, the absorption value can be previously determined and subsequently the appearance and elasticity of the gluten noted and examined on the same sample.

The method of procedure for obtaining the absorption value and washing out of the starchy material is as follows: 33.33 g. of flour is weighed into a beaker and 15 c.c. of cooled distilled water is added from a burette. It must be remembered in connection with the washing out of the starch that the temperature of the water is of importance, i.e., must be kept cool. Then ½ c.c. of water at a time is added until a dough of proper consistency is formed. The number of c.c. of water used multiplied by 3 equals the absorption of the flour for water.

Enough water is now added to cover the dough and same set aside for 1 hr., after which it is washed out over a screen of bolting cloth, using cooled (in summer cold) water, until free from starchy material. Care must be exercised not to have the water flowing too fast, as it tends to divide the gluten into small particles which are hard to incorporate with the main portion. Care must also be taken not to extend the washing-out process over too long a period of time, as this causes the gluten to adhere to the fingers. Any loose or small pieces of gluten which have been caught on the bolting cloth screen can be gathered by using the main ball as a swab. The screen is made by fastening silk bolting cloth (125 mesh to the lineal inch) into the largest size obtainable embroidery frame. The gluten thus gathered into one ball is put in a beaker using fresh cooled water and allowed to stand for an hour, after which it is observed as to its elasticity and quality, which are determined by physical examination.

Glutens of excellent quality will have a light or creamy color, will remain solid and will be elastic. There is, however, a difference in the elasticity of excellent quality gluten. Some stretch very readily without breaking, while others offer more resistance. This aids in a preliminary way in determining the use of a flour, i.e., whether it is adapted for crackers or cakes.

Method of Determining the Heat Action on Gluten

The following method was developed in determining the heat action on gluten and has been termed the "expansion test": The moisture from the isolated gluten is removed by pressing the gluten between the palms of the hands and the fleshy part of the thumb. Care must be taken to have the hands cool (which is usually accomplished by allowing water to run over the wrists). The hands must be frequently dried during this operation. The gluten is then rolled into a ball and transferred to a clean, previously weighed, zinc plate about 2 in. square, which is then placed in an electrically heated oven or furnace, where a temperature of 158 to 160 deg. C. is maintained for 18 min. At this temperature and for this time the best expansion of the gluten is obtained. It is then transferred to a drying oven maintained at 100 deg. C. for a period of 16 hr. (usually over night), then weighed and dried to a constant weight at hourly intervals. It has been found that all the moisture has been expelled in the 16-hr. period when the test is conducted as above.

The measuring of the expansion is accomplished as follows: The gluten ball is carefully removed from the zinc plate (zinc plates are used because the adhesion of gluten to zinc is less than in the case of other metals or glass) and placed in a 2½-in. cubical measuring box with sliding lid. Seeds of fair size (such as hemp) are added (from a graduated cylinder filled with the seed and whose cubical contents equal that of the box) until the box is filled. The seeds remaining in the cylinder give the cubical contents of the volume occupied by the gluten ball. The volume thus obtained, divided by the number of grams of dried gluten, equals the exp[illegible]

sion per gram of gluten, which when multiplied by the per cent of protein obtained by chemical methods equals the total expansion volume of the gluten in terms of c.c. per 100 g. of flour.

TABULATED AND PLOTTED RESULTS OF FLOUR ANALYSES

A statistical study is then made every season (usually about August, when the new flour comes in) of the expansion factor with reference to the protein, gluten (by washing-out method) and the ash determinations. Table I gives the information in tabular form, supplemented by curves and comments thereon, of a typical season.

The curve sheets show clearly the variations encountered in flour analysis. Fig. 1 illustrates the variation met with in protein content and gluten value. Fig. 2 combines the data as given in Fig. 1 with the ash value, which is the index as to how the wheat was milled to produce the flour.

A high-grade flour most generally has a low ash value. A 40 per cent patent means that only 40 per cent of the wheat was used (i.e., the best part), while a 60 per cent patent would be milled from 60 per cent of the wheat and hence would contain more mineral matter, with a resulting higher ash content. It has been observed, however, that flour obtained from wheat grown on the

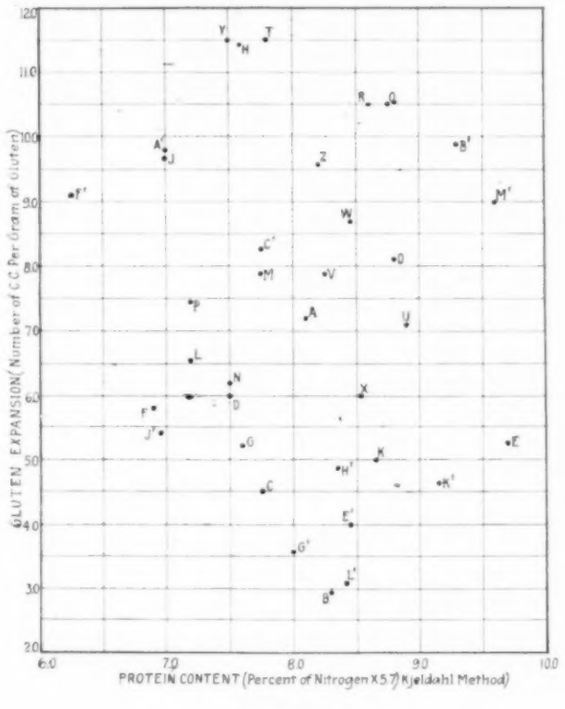


FIG. 1.

Pacific Coast has a high ash value due to the soil in which the wheat is grown.

The total gluten expansion value gives with one figure the combined quality and quantity value of the gluten. Having worked out, at the beginning of the season, charts similar to those given, it is a rather easy matter on subsequent analyses for the same season to determine just where a flour belongs and what it can best be used for, crackers or cakes, and also what kind of cakes.

The absorption value tells how much water to use in your mixes and the moisture determination tells how much water you are paying for.

In a similar manner, standard specifications were

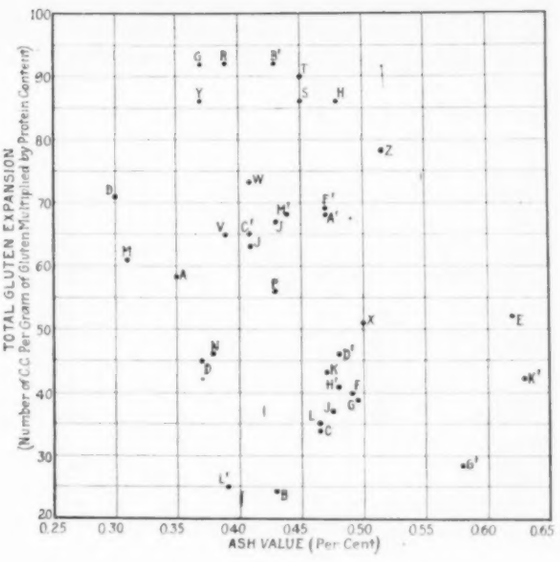


FIG. 2

worked out for other raw materials. Chief among these were:

1. Butter, lard and shorteners; in which it was found advisable to make melting point, refractometric, moisture, ash (including salt), casein determinations; obtaining fat by difference. Special attention must always be paid to color, taste and odor.

2. Milk products and milk powder; make ash, moisture, fat (Babcock method—Leach) determinations.

3. Molasses, syrups, sugar; make moisture, invert sugar and sucrose determinations.

4. Flavoring extracts; make specific gravity determinations and observe taste.

5. Baking powders; make acidity tests and determine starchy material.

TABLE I.

Lot Symbol	Protein in Per Cent (5.7 × N)	Gluten in Per Cent	Gluten Expansion in c.c.	Gluten Expansion per g. of Gluten (calc.)	Total Expansion per 100 g. of Flour (calc.)	Ash Value Per Cent
A	8.07	9.30	22.3	7.20	58.20	0.35
B	8.32	10.65	10.8	2.95	24.60	0.43
C	7.73	9.45	14.1	4.48	34.60	0.47
D	7.51	9.15	15.0	6.00	45.00	0.37
E	9.69	11.10	19.5	5.27	51.00	0.62
F	6.90	7.65	14.8	5.80	40.00	0.49
G	7.60	7.95	13.8	5.22	39.60	0.39
H	7.55	8.40	32.0	11.40	86.00	0.48
J	7.00	7.35	23.5	9.60	67.00	0.43
K	8.66	9.75	16.2	5.00	43.30	0.47
L	7.19	8.70	19.0	6.56	47.20	0.35
M	7.74	9.30	24.5	7.90	61.20	0.31
N	7.50	7.00	14.5	6.18	46.40	0.38
O	8.79	8.15	22.0	8.08	71.00	0.30
P	7.20	6.77	16.8	7.45	53.60	0.43
Q	8.74	10.80	37.7	10.45	91.50	0.37
R	8.59	10.50	36.6	10.45	91.50	0.39
S	8.50	10.20	30.0	10.20	86.80	0.45
T	7.80	9.90	38.0	11.50	89.60	0.45
U	8.90	9.15	21.6	7.10	63.20	0.51
V	8.27	9.00	23.8	7.86	65.00	0.39
W	8.46	10.05	29.0	8.70	73.50	0.41
X	8.55	10.50	21.0	6.00	51.30	0.50
Y	7.51	9.75	37.5	11.50	86.40	0.37
Z	8.18	10.35	33.0	9.56	78.40	0.52
A′	6.96	8.40	26.3	9.80	68.00	0.47
B′	9.29	10.50	34.7	9.90	92.10	0.43
C′	7.75	8.40	20.9	8.22	63.60	0.41
D′	10.46	11.40	17.0	4.40	46.00	0.48
E′	8.41	10.05	15.0	4.50	37.80	0.39
F′	6.25	6.90	25.3	11.00	68.80	0.47
G′	7.92	9.90	10.6	3.56	28.20	0.58
H′	8.34	8.40	13.6	4.85	40.50	0.48
J′	6.98	7.65	13.7	5.36	37.40	0.48
K′	9.17	10.55	16.3	4.64	42.60	0.63
L′	8.41	9.36	28.5	3.04	25.60	0.39
M′	7.59	10.50	31.5	9.00	68.20	0.44

The most striking example of the methods of manufacture studies was "Ammonium Carbonate Versus Ammonium Bicarbonate." Merck's 1907 Index gives the following information about the two salts:

Ammonium Bicarbonate—Large, transparent crystals, soluble in water and alcohol. Decompose at 60 deg. C.

Ammonium Carbonate—Mixture of ammonium bicarbonate and ammonium carbamate. Crystals, white, efflorese in air, stringent ammonia odor, sharp saline taste, soluble in five parts water at 15 deg. C. Decomposed by hot water.

Analyzing the samples for ammonia content, it was found that the commercial products as furnished to the baking trade gave the following figures: Ammonium bicarbonate, 20.86 to 21.05 per cent. Ammonium carbonate varied from 22.50 to 25.60 per cent.

It will be readily seen that the ammonium carbonate does not aid in producing uniformity of product, as it is itself quite variable in constitution. It is true that as to ammonia content it is stronger and hence would be more economical, as its function is to produce volumes of ammonia gas. An attempt was made to get the same baking results by using ammonium bicarbonate in sufficient quantities to equal the ammonia content of ammonium carbonate. The results, however, did not equal those ordinarily obtained. It was then decided to investigate the manner of mixing and also the baking. This investigation showed that certain kinds of cakes must have a leavening agent which is capable of acting quickly upon the application of heat. This was found to be true of ammonium carbonate, as it is more unstable than ammonium bicarbonate.

Test of Acidity in Sponges Used in the Baking Industry

Another example of this type of studies is "Acidity in Sponges in the Making of Crackers."

By "sponge" in the baking of crackers is meant that portion of the raw materials which is mixed in advance with the fermenting agent. This sponge is allowed to stand for a long time, becoming acid due to the fermentation. This acidity is neutralized with sodium bicarbonate when the remainder of the raw materials are added to make the dough, which in turn goes through a fermenting period of short duration. Experience has shown that when all other figures or factors are constant, there has been developed an empirical relationship between the temperature of the sponge just before mixing and the amount of soda to be added. When other variables enter into the mixing conditions, erratic temperatures are obtained. To take these variables into consideration, the following chemical method was developed. The sponge is sampled and exactly 20 g. weighed out into a white enameled dish and distilled water added to dissolve the sponge thoroughly. Standard alkali is run in from a burette to neutralize the acidity, using phenolphthalein as an indicator. The burette is so graduated as to read per cents directly. A table furnished to the workman performing this test tells how much soda to add. This table was prepared in the laboratory making acidity determinations on the sponge and also on the finished products resulting therefrom. In this way any erratic temperatures are subjected to chemical checking.

The finished product and industrial engineering studies were more closely correlated than in the two preceding groups and accordingly do not offer isolated examples.

In the cracker industry we have the following factors entering into production and costs: In the making of approximately two hundred different kinds of finished products, sixty different materials are used. These products are made on ten different ovens or machines. Each product has its own die or cutter for cutting out the cake. Each dough has its ideal speed at which the cutter will work effectively. There is also an ideal time for baking and a certain number of operators are required for each product. The finished cakes will average so many to a pound, depending upon the cake. Similarly, there is an average weight for each packing container (large can, small can, wood boxes, barrels, drums and cartons), and there is a certain speed of packing, depending upon the size and nature of the product.

All of the above factors vary from day to day, and as a result the determination of standards representing ideal operating conditions was an extremely difficult task.

The standard method adopted by which to measure production and cost standards in the cracker baking industry requires a knowledge of the following:

1. Determine the number of cakes cut out with every stamp of the cutter.
2. Determine the ideal speed (ideal referring to speed at which the resultant product is best obtained) at which to operate the cutter, i.e., cuts per minute.
3. Determine the average number of cakes per lb.
4. Determine the minimum number of operators who can effectively turn out the product.

The above applies to manufacturing departments as contrasted to packing departments.

In the packing departments, it was necessary to set up an individual standard for each product in each and every kind of packing container.

Since the goods are sold on a pound basis, it is evident that the cost standard must include pounds in its expression or terms. Furthermore all production and cost standards involve time. If the machine cost variance is great and the machines are operated by the same number of operators, then the machine hour basis is most applicable. In the cracker-baking industry the variance is found in operators and not in the cost of the machines. Hence the most applicable and accurate production standard is expressed as pounds produced per operative hour or the pounds produced per person per hour. For cost work, it takes a more convenient form, its reciprocal, or part of an operative hour required to produce 100 lb.

In the course of a day there is manufactured approximately fifteen different styles of goods, each with a different rate of production as follows:

Product A	100 lb. per person per hour
Product B	174 lb. per person per hour
Product C	102 lb. per person per hour
Product D	170 lb. per person per hour
Product E	147 lb. per person per hour

The respective cost standards are:

Product A	1.000 operative hr. to produce 100 lb.
Product B	0.575 operative hr. to produce 100 lb.
Product C	0.980 operative hr. to produce 100 lb.
Product D	0.590 operative hr. to produce 100 lb.
Product E	0.689 operative hr. to produce 100 lb.

The production rate of "lb. per operative hr." is computed according to the following equation:

$$\textit{Pounds per operative hour} = \frac{\textit{Cakes per cut} \times \textit{cuts per min.} \times \textit{operating min. per hr.}}{\textit{Number of operators} \times \textit{cakes per lb.}}$$

It was necessary, in installing a system of this design, first to explain thoroughly to department heads just how the reports were to be made out—that is, to distinguish between direct help (working on the particular machine) and indirect help (foreman, mixers and others who are intermittently working on several varieties of goods at one time), to take accurate speeds and keep accurate time, so that the data represented true and actual conditions; secondly, to explain to the cost department assistants how to interpret correctly the data submitted and compute the production rates as well as to detect inconsistencies. For a certain period of time it was necessary to make computations of standards daily on each and every run in order to check up intentional carelessness on the part of some in assembling the data; after which it was possible to fix a certain standard rate of production. By dividing this standard rate of production for any given variety into the total pounds produced in any day, it is possible to obtain the time equivalent in operative hours of direct help of work produced. Dividing this time equivalent by the actual time spent by the operatives on the particular run, the efficiency of the run is obtained.

Standards Representative of Operating Conditions

If the efficiency thus obtained is abnormally low, then it is due to one of two conditions: (1) abnormal operating conditions (necessitating a change of standard), or else (2) indifference on the part of the operatives to maintain the production standard as set. In the case of abnormally high efficiencies, the standard is set too low, or else the data as submitted do not represent true conditions. In this way the standards receive constant checking and represent actual or operating conditions.

In the packing department it often occurs that several kinds of packages are being packed at one time off of one run, and therefore the best method to set standards was found to be by making time and motion studies for each and every piece and container. This requires careful and keen observation and unprejudiced conclusions. In a few instances it was found that group studies could be made.

Time and motion studies in the cracker industry on packing operations are quite different from studies in the machine shops, due to so many variables and also due the fact that the operators are girls unfamiliar with time and motion study work; hence it was most difficult to have them understand just what was wanted.

Factors in Time and Motion Studies

The following are the observations which must be made in connection with time and motion studies of packing operations in the cracker-baking industry:

1. How are crackers brought to the packers? (On conveyors or on trays in stacks.)
2. How are packing containers supplied to the packers?
3. Do packers pack from conveyors?
4. Movement of conveyors—intermittent or regular?
5. Kind of product—cracker or cake?
6. Size of product?
7. Shape of product?
8. Thickness of product?
9. Do products stick to conveying pans?
10. Are stackers required?
11. Time to pack each individual layer.
12. Time to face front of containers.
13. Number of crackers or cakes per row.
14. Number of rows per layer.
15. Number of layers per container.

Determination of Plant Efficiency

Having determined the standards, the efficiency is determined as follows: The weight of goods packed in style I container is divided by the standard (for that particular container), giving the time equivalent for style I; similarly style II is treated, etc. Then the time equivalents expressed in operative hours of work produced of all the styles of containers for one variety of product are added and the sum is divided by the total number of operative hours of direct help, giving the efficiency. It is more difficult to detect errors in setting standards in the packing operations, as the effect of any single standard is masked in arriving at the efficiency per cent.

The time equivalents or standard operative hours of work produced for all varieties in a department are totaled for a given period of time (usually a month). These totals are then divided into the departmental labor charge (includes both direct and indirect help for the same period of time), giving the operating labor cost per operative hour. Similarly, the same totals are divided into the departmental burden, giving the burden cost per operative hour.

In calculating the cost of labor and burden on any piece or variety of goods, the cost unit (part of an operative hour required to produce 100 lb.) is multiplied by the rate per operative hour, giving the cost per 100 lb.

Conclusion

The difficulties in installing a system of this kind are the usual ones met with in installing any new industrial engineering system, namely,

1. Convincing every one concerned as to the importance of co-operation.
2. Designing suitable forms, reports and cards.
3. Interpreting and straightening out details which cannot be covered by a set of general instructions.

It must be remembered that owing to seasonal variations in the raw materials, factory methods are constantly changing, and accordingly the members of the cost department must always be on the alert to detect any irregularities.

This system has been in operation for two years and has been developed to such an extent that standard costs as calculated are proved against the actual departmental costs with only a very small percentage of variance. In this way it is possible to ascertain just what goods are creating and what ones are not creating departmental profits and also to anticipate new production costs very accurately.

In connection with the time studies on packing operations, a piece rates schedule was set up which increased production without increasing costs. This schedule is closely co-ordinated and consistent with the cost standards as set.

Summarizing the results of this investigation it has been shown that some of the functions of the chemical engineer in the cracker and biscuit baking industry are:

(*a*) Setting up standard specifications for purchase and control, checking of raw materials used.

(*b*) Investigating methods of manufacture and giving technical assistance.

(*c*) Solving industrial engineering problems.

Cincinnati, Ohio.

Legal Notes

By Wellington Gustin

Judgment for Refusal to Ship Phosphate Upheld

The judgment of the Clinton Oil & Manufacturing Co. of Clinton, S. C., against J. H. Carpenter, president of the Tennessee Fertilizer Co. of Nashville, has been affirmed in the Supreme Court of South Carolina. The action was for damages for failure to deliver acid phosphate under a contract, the material part being in these words:

"J. H. Carpenter agrees that he will sell to the other parties to this contract . . . acid phosphate during the two seasons, May 1, 1916, to May 1, 1917, and May 1, 1917, to May 1, 1918, at the price of $8.50 per ton f.o.b. cars at the plant of Carolina Phosphate Co., near Greenville, the fertilizers to be paid for on May 1, 1917, and May 1, 1918, respectively."

The present case grows out of the transaction for the fiscal year May 1, 1916, to May 1, 1917, the amount of acid phosphate agreed to be sold being 1,000 tons. Of this amount 160 tons was delivered and defendant refused to deliver the balance of 840 tons.

The persons involved in the whole transaction are the Tennessee company, represented by Carpenter, its president; Sparrow, its secretary at Nashville; Todd, the local agent and manager of the Carolina Phosphate Co. at Greenville and an agency of the Tennessee company; Bryson, the head of two corporations organized under the laws of South Carolina, the Woodruff Oil & Fertilizer Co. at Woodruff, S. C., and the Clinton Oil & Manufacturing Co. at Clinton, S. C.

Holdings of the Court

Looking at the contract, the Supreme Court said the phosphate was to be delivered to the Clinton company before May 1, 1917, as it was the end of the fiscal year, and payment was then due. Therefore, if the plaintiff did not call for an execution of the contract by asking delivery to it before May 1 of the 1,000 tons, the plaintiff has been done no wrong.

The contract does not prescribe by what formality, in time or in agency, the buyer should call for delivery of the acid, said the court; it does not prescribe that the call for delivery shall be intermittent, or that it shall be in writing. The seller's witness testified that it was the custom of the trade in carrying out a contract of this kind to ship from time to time during the season, and not all at one time; the custom being to give orders from time to time with shipping instructions. There were six of such orders filled for plaintiff during the latter half of January, 1917, aggregating 160 tons, and all shipped to Woodruff.

Contention of Defendant

Now, the seller contended that he was instructed by buyer Feb. 1 not to make any further shipments until "we write you again," and that the buyer made no further call for shipment until April 30, when it telegraphed: "If compelled to have shipping instructions, ship balance Woodruff Clinton acid to Spartanburg." His consequent contention was that this instruction, though within the letter of the contract, came too late for him to comply with the contract, and it was therefore inoperative.

Further testimony showed that the Tennessee Fertilizer Co. wrote the buyer, plaintiff, on March 19, and inquired to ascertain "the total amount of acid phosphate which you will take during the current season, ending May 1, 1917," to which letter the buyer replied on March 21, that it "expected to take the amount the contract calls for." The court said that with this reply before him there was no warrant for defendant to have been misled by the buyer's letter of Feb. 1. Mr. Bryson testified that the seller frequently had been requested, in person and by phone message, to ship out the balance of the contract. But Todd testified he never recognized verbal orders coming to him over the phone, though he admitted he suspended shipments upon request by phone to do so.

The question of whether the buyer had ordered shipment of balance of goods in time for shipment before expiration of period the court held for the jury to decide, as was also the question of whether seller waived his right to have buyer's orders for shipment in time to ship goods before expiration of the period.

And it said that when one party to a contract notifies the other party that he elects to breach the contract, the other party need not make tender to sell, since tender would be an idle performance.

Again, the damages to a buyer for failure of the seller to deliver goods were measured by the market value of the goods at time and place of delivery, or, if not ascertainable at place of delivery, at nearest market place plus cost of shipment to place of delivery. But buyer's ability to have made a profit by resale to others may not be recovered as damages.

Held Guilty of Contempt for Refusal to Testify

William A. Rushworth has been held guilty of contempt in the Circuit Court for Cook County, Illinois, for failure to testify and to produce certain documents in the matter of the Imperial Trust Co. of Canada, Ltd., vs. W. Howard Jackson, the case now pending in the Supreme Court of Ontario, Canada. A commissioner has been appointed to take evidence of several witnesses in Chicago, including George M. Reynolds, president of the Continental & Commercial National Bank, Armour & Co., Stuart G. Shepard, Central Trust Co. of Illinois, Sheridan Trust Co., Colonel R. R. McCormick and a number of manufacturing companies. Responding to a subpœna, Rushworth appeared, but refused to testify or produce desired documents.

Counsel for Rushworth said he would refuse to obey the court's order on the ground that it was without jurisdiction and authority to enter such order, and that the Illinois statute permitting the taking of the evidence is contrary to Section 9, Article II of the Constitution of Illinois. An appeal from the court's order was allowed to the Supreme Court of Illinois.

The order of the court was for Rushworth to appear before the commissioner and answer questions as to:

"An agreement between William A. Rushworth and the Tennessee Copper Co., as regards the sale or purchase of toluol and sulphuric acid.

"A certain contract for the supply of toluol to the Canadian Explosives Co. by the Tennessee Copper Co.

"A certain copy of a tender for toluol to the Imperial Munitions Board for 15,000 gal. of toluol monthly on behalf of the Tennessee Copper Co. made through William A. Rushworth."

The Hot-Process Water Softener

A Study of the Rate of Sedimentation of Lime and Magnesia Precipitates During Softening at Low and High Temperatures—Plant Equipment: Reagent Proportioner, Tanks and Filter

BY GEORGE H. GIBSON

THE hot-process softener, in its present form, is a recent development. By taking advantage of the fact that chemical reactions are more rapid and complete in hot water than in cold water, more efficient removal of scale- and sludge-forming substances are obtained. The apparatus performs the functions of the open feed-water heater usually found in steam-boiler plants, in addition to those of a softener, and less space, lighter foundations, less housing, less piping and fewer fittings are required than for a cold-process softener plus an independent heater. There are several reasons why scale-forming matter is more completely removed from hot water than from cold water.

EFFECT OF HEAT UPON REACTIONS

Chemical reactions are enormously accelerated by heat. This is a well-known and generally recognized fact, and was used in the household for ages before it assumed the dignity of a law of chemistry. Everyone knows that dishes and clothes are washed more rapidly and thoroughly in hot water than in cold water. Paper pulp is causticized in hot water, etc. The exact law connecting temperature and rapidity of chemical reaction has never been determined accurately, some chemists stating that the speed of reaction doubles for each 10 deg. C. added to the temperature, and others that chemical reactions are speeded up approx-

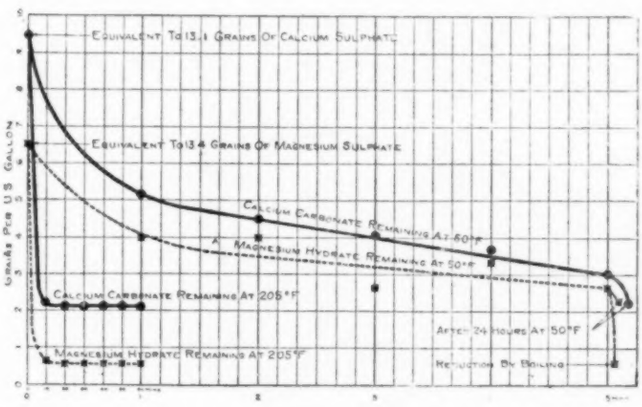

Equivalent To 13.1 Grains Of Calcium Sulphate
Equivalent To 13.4 Grains Of Magnesium Sulphate
Calcium Carbonate Remaining At 50°F
Magnesium Hydrate Remaining At 50°F
Calcium Carbonate Remaining At 205°F
Magnesium Hydrate Remaining At 205°F
After 24 Hours At 50°F
Reduction By Boiling
Grains Per U.S. Gallon

FIG. 1. RATE OF SEDIMENTATION AT 50 AND 205 DEG. F.

imately as the twentieth power of the absolute temperature. Those formulas are not in agreement, but everyone concedes that there is a tremendous increase in speed of reaction with rise in temperature.

Some years ago experiments were made in the chemical laboratory of the Harrison Safety Boiler Works to determine the effect of temperature upon the reactions which take place between softening reagents and scale-forming matter in boiler-feed water. The results are shown graphically in Fig. 1.

It will be seen that the reduction in hardness, that is, in content of calcium and magnesium salts, is much greater at the end of 10 min. in water at 210 deg. F. than at the end of 5 hr. in water at 50 deg. F.; in fact, 24-hr. treatment in cold water does not bring the scale forming matter down as much as does 10-min. treatment in hot water. Subsequent heating to the boiling point of the sample which has stood at 50 deg. F. for 5 hr. reduces the magnesium hydrate to less than 1 grain per gal., but the same result is obtained in hot water in 10 min. In performing these experiments, only sufficient softening chemical was added to combine with the scale-forming substances. In practice a slight excess is used, which reduces the hardness to lower figures.

FACTORS OF RATE OF SEDIMENTATION

The precipitates resulting from the transformation of scale-forming substances also settle more rapidly and completely from hot water than from cold water. Solid particles suspended in water settle to the bottom if their density is greater than that of the water or rise to the top if their density is less than that of the water. The force acting upon the particles is its weight less the weight of water displaced, and the force by which it is resisted depends upon the extent of its surface and the viscosity of the fluid in which the particle is suspended, multiplied by the velocity of fall. A maximum velocity is reached at which the retarding force is just equal to the accelerating force.

Viscosity is the resistance which a fluid offers to shearing. The coefficient of viscosity may be defined as equal to the tangential force required to slide a unit surface at unit velocity a unit distance from another surface with the fluid between.

Obviously, a large particle will settle more rapidly than a small particle because it contains a greater mass, and hence is acted upon by a greater force, in proportion to its surface. Considering a spherical particle whose density is greater than that of water, the maximum velocity with which it falls is given by Stokes' formula

$$V = \frac{2}{9}\frac{D-d}{N} gr^2,$$

in which V is the velocity, D the density of the particle, d the density of the water, g the acceleration of gravity, r the radius of the particle and N the coefficient of viscosity.

In a water softener the precipitated particles are of various sizes and possibly of different densities, but any given particle will fall through water at a rate depending upon the viscosity, and it is therefore of interest to note how the viscosity of water changes with temperature as shown in Table I, by Thorpe & Rodger.

TABLE I.

Temp., Deg. F.	Coefficient of Viscosity	Temp., Deg. F.	Coefficient of Viscosity
32	0.01778	140	0.00468
50	0.01303	158	0.00406
68	0.01002	186	0.00356
86	0.00798	194	0.00316
104	0.00654	212	0.00283
122	0.00548		

At the freezing point the viscosity of water is over six times as great as at the boiling point, while as between water at 68 deg. F. and water at 212 deg. F., the increase in velocity of fall will be about four times.

Now consider how this applies in a water softener. Suppose we have a large tank full of absolutely quiet water. A particle of any given size will descend four times as far in an hour in hot water as it will in cold water.

Next, suppose we have a continuous softener in which the water is constantly flowing through the sedimentation tank. The rate of flow can be four times as great in a hot-process water softener as in a cold-process softener without carrying particles of a given size to the pump supply pipe; or, to put it in still another way, with a given rate of flow through the settling chamber, much smaller particles can be separated out in the hot-process softener than in the cold-process softener. The further fact that the particles formed in a hot-process softener are larger than those formed in a cold-process softener renders the advantage of the hot process still greater, since the velocity of fall increases as the square of the radius of the particle.

It is therefore plain why the preliminary heating of the water, a feature which is peculiar to the hot-process softener, gives more complete chemical reactions and more thorough removal of the resulting precipitates.

Report on Hot-Process Test Run

The completeness with which scale-forming matter is removed from water treated in a hot-process softener may be shown by the analyses of water (Table II) before and after treatment in a commercial installation. In considering these results, it should be borne in mind that a grain is 1/7,000 of a pound, or 1/58,415 of the weight of a gallon of water. The small amount of solids remaining in the treated water from a hot-process softener does not form scale in the boiler, but gathers a sludge, which is easily blown out.

The chemical reagents must be fed to a softener accurately in proportion to the amount of water and to the impurities in the water, so that the treated water may not deposit scale on the one hand, or contain an excess of unused reagents on the other. For proportioning the reagents to the raw-water supply various mechanical arrangements have been devised.

Methods of Proportioning Softener and Water

In some softeners, the raw water flowing to the softener turns a waterwheel or operates a tilting bucket which in turn operates dippers by which the reagents are ladled out to be mixed with the raw water. Such appliances, widely used with cold-process softeners, are usually located above the reaction chamber of the softener, involving the lifting or hoisting of the reagents 15 or 20 ft. or more above the ground level.

In other softeners, a certain portion of the water, divided from the main supply by means of orifices or weirs, flows through chambers containing the reagents. In one such proportioner, the water, in flowing through the reagent tank, becomes saturated. This method is faulty, however, since solubility varies greatly with temperature.

In another form the water displaces the reagent from a tank, at the same time diluting that which remains in the tank. Elaborate means for adjusting the orifices progressively as the reagents become more and more dilute are therefore required.

None of these methods is well adapted for feeding chemicals to a hot-process softener, which should be designed for operation under a few pounds back pressure, since it is necessary to carry a few pounds back pressure upon the exhaust steam in order to insure a temperature of at least 205 deg. F. of the treated water at all times. With the methods just mentioned, it is necessary that the chemical feeding equipment be

TABLE II. ANALYSES OF WATER BEFORE AND AFTER SOFTENING

	Grains per U. S. Gallon Before Softening	After Softening
Calcium sulphate	13.00	None
Calcium carbonate	12.30	0.36
Magnesium carbonate	5.36	0.94
Silica	0.82	0.35
Iron and aluminum oxides	Trace	Trace
Total incrusting solids	31.48	1.65
Organic and volatile	6.32	2.98
Sodium carbonate	.....	4.80
Sodium sulphate	0.64	12.60
Sodium chloride	2.28	1.92
Total non-incrusting solids	9.24	22.30
Free carbonic acid	2.45	.....

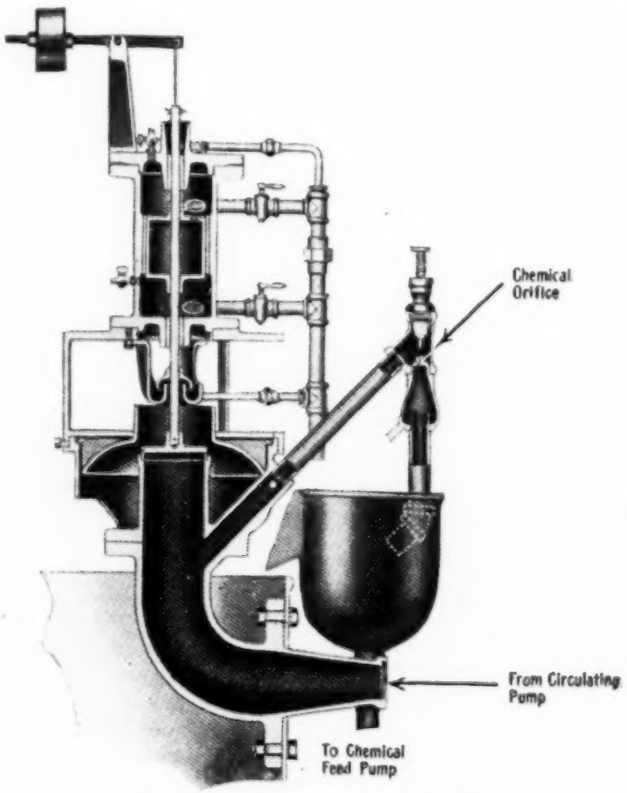


FIG. 2. CHEMICAL PROPORTIONER

inclosed within the steam space or else that the chemical and raw water, after being proportioned, be pumped into the softener against the back pressure. If the waterwheel, or the tilting bucket, is inclosed so that the reagents can flow by gravity directly to the reaction

chamber, steam finds its way into the chemical tank, where it condenses, diluting the reagents and rendering the feed inaccurate. The divided flow method involves an additional pumping of both the raw water and the reagent, and is therefore complicated and expensive.

In still another arrangement the raw water is passed through a hydraulic motor, of the reciprocating or of the rotary form, which drives a small chemical pump. This method is defective because it is practically impossible to prevent slippage past the valves and packings of such motors and pumps, which renders the proportioning inaccurate.

The chemical proportioner used in the Sorge Cochrane Hot-Process Softener to regulate the feed of chemicals in proportion to the flow of raw water is a true flow proportioner. The chemical to be fed to the softener is forced through an orifice by a pressure just equal to the differential pressure set up by the flow of the raw water through an orifice in the supply pipe.

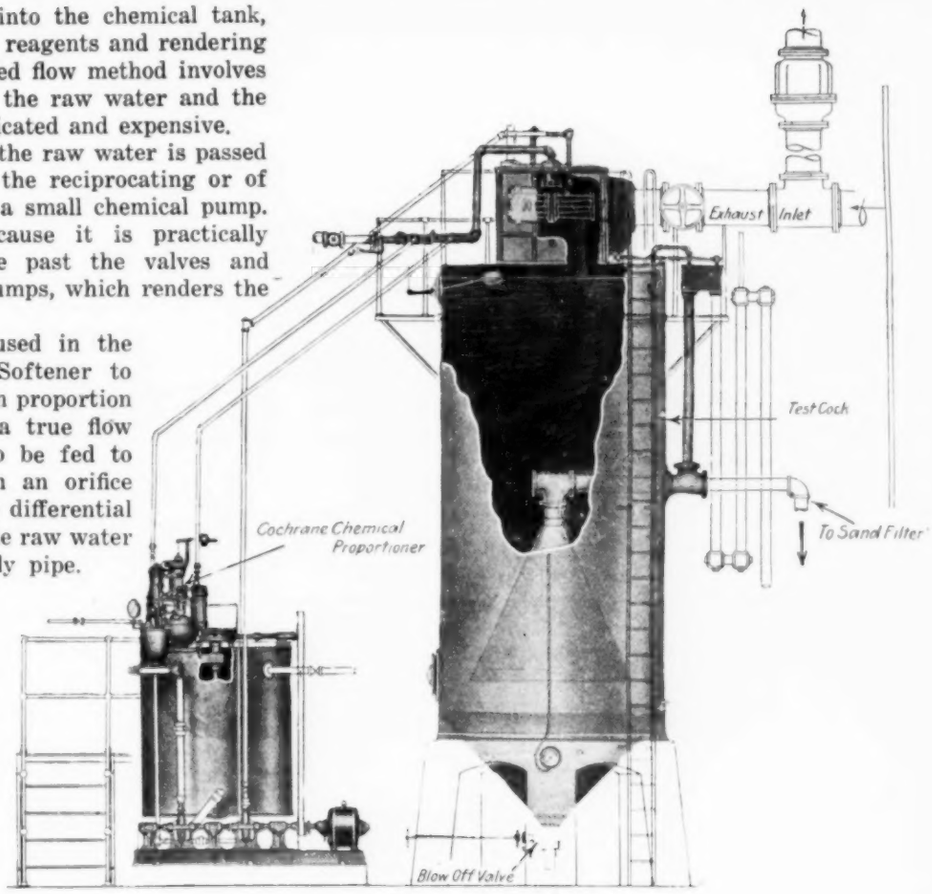


FIG. 3. HOT-PROCESS WATER SOFTENER INSTALLATION

Operation of the Softener

To understand how the device works, refer to Fig. 2. Between two flanges in the pipe through which the raw water flows to the heater at the top of the softener is placed a thin orifice disk. From the two sides of this orifice, small pipes lead to the opposite ends of a cylinder containing a piston. The piston is thus acted upon by the differential pressure due to the flow of water through the orifice. The vertical piston rod extends through water glands at each end of the cylinder. On the lower end of the rod is a valve disk, which closes over an opening through which a fluid mixture of the reagents is constantly being forced by a centrifugal circulating pump. The weight of the piston, rod and valve disk is counterbalanced. The differential pressure acting upon the piston pushes the disk down upon and tends to close the opening, while a pressure builds up underneath just sufficient to balance the differential pressure. The pressure of the chemical solution is therefore directly controlled by the differential pressure resulting from the flow of water through the orifice in the raw-water pipe. Through a simple pipe connection, this pressure acts directly at the chemical orifice, insuring an effective pressure on this orifice at all times equal to the differential pressure on the raw-water orifice. Most of the chemical solution supplied by the circulating pump flows out from under the disk and through a strainer and hence back into the chemical solution tank. The proportioned chemical flows through the chemical orifice into a funnel, from which it is taken by a chemical feed pump, lifted to the softener and forced in against any back pressure that may exist in the latter. The back pressure in the softener thus does not affect the proportioning. As the chemical, before escaping through the small orifice, is not in contact with air, no incrustation occurs therein, but to provide for dislodging any obstruction, a cleaning needle is so arranged that it can at any time be forced through the orifice by the pressure of the hand.

Besides being accurate, this arrangement has other advantages: Only one chemical solution tank is required, which is at the ground level, where it can be charged without hoisting of chemicals or inspected without climbing a ladder. The motor which drives the circulating pump also drives agitating paddles in the tank. Milk of lime can thus be kept in suspension and fed as well as purely fluid reagents. The large saturator tanks necessary where lime water is used are eliminated and the difficulty due to the fact that lime water varies in strength according to temperature is avoided. Solutions of caustic soda or sodium carbonate, lime water, milk of lime, or any mixtures, are all handled equally well and fed accurately.

The accuracy with which the solution is fed is well within 2 per cent, which is closer than attendants will measure out chemicals into the chemical tank. Representative test results are shown in the following table:

Rate of Flow of Raw Water Gal. per Hr.	Rate of Flow of Chemical Gal. per Hr.	Chemical per Gal. of Water	Variation Per Cent
1740	134.6	0.0773	0.28
1590	122.2	0.0769	0.22
1410	108.4	0.0769	0.22
1160	88.8	0.0766	0.71
710	54.6	0.0769	0.22
411	31.8	0.0773	0.28
290	22.4	0.0773	0.28
290	22.5	0.0775	0.52
184	14.3	0.0771	0.03

The chemical treatment is controlled by drawing a sample of the treated water from time to time and titrating with standardized solutions, the whole operation requiring about 10 min. By locating the titration readings thus obtained upon a chart for correct chemical treatment, the operator sees at a glance what change, if any, is required in the amount of the chemicals.

The apparatus, as may be seen in Fig. 3, is simple and compact. The open heater, with an oil separator attached for purifying the exhaust steam used for heating the water, is mounted directly over the reaction and sedimentation chamber. The water is heated to steam temperature by spraying it over trays, which also serves to release oxygen and other dissolved gases. It is then mixed with the reagent and fal's directly into the sedimentation tank. There is no constricted piping between heater and tank to become choked with scale. In fact, the water does not pass through piping from the time when it is first heated until it has been through the sedimentation chamber, even the overflow receiving only settled water.

The precipitated matter deposits in the conical bottom of the sedimentation chamber, from which it can be quickly washed by the opening of a single valve. In order to eliminate convection currents the hot water and the softening are delivered at the top and travel slowly to the bottom, from which the clarified water is drawn off by an inverted funnel. The precipitates formed when the water is first mixed with the chemical fall through the water below, securing a screening effect and gathering together the smaller particles. All precipitates are carried to the conical bottom of the tank, from which they are readily blown out by opening a sludge valve at the lower end or apex of the cone.

Filters

The removal of scale-forming matter at high temperature by sedimentation is so effective that for many waters and plant conditions it is entirely practicable to dispense with filters. Many softeners are accordingly installed without filters and are successfully protecting the boilers from scale and corrosion, even though the softened water contains a slight amount of suspended matter. Other conditions demand the use of filters, for which a low-pressure sand filter is placed between the sedimentation tank and the boiler-feed pumps or meter, the water flowing through the filter by gravity. These filters deliver a crystal-clear water which contains no solids except those in solution and no mud-forming properties except the amount which is below the exceedingly low limit of solubility of calcium and magnesium monocarbonates, silica, etc., at the boiling point. This water will leave no troublesome deposit in the feed lines, pumps or meters, and is particularly suitable for boilers operated at high ratings.

The filter is essentially a bed of fine sand resting upon a bed of gravel. Embedded in the gravel layer are strainer heads or valves. The strainer valves are of a self-cleaning type, having a movable head or disk which rests upon the stationary part of the valve in such a way as to leave small openings or ports around the edge. In back washing, the water is admitted through the strainers in a reverse direction and lifts the disks or heads, increasing the openings of the ports to double the normal size, with the result that any particles of sand or other substances which may have lodged in the port during the filtering operation are released and carried out by the wash water.

The strainers may be screwed into a collecting and wash-water distributing manifold, as illustrated in Fig. 4, or into a diaphragm.

Embedded in the gravel layer is an air-distribution system consisting of a main pipe with laterals, the latter perforated on the under side to permit the escape of air throughout the gravel layer. The air is used for loosening up the filter bed preliminary to back washing, the proper rate of air admission being controlled by an orifice in the pipe connection.

The filter chamber is connected to the softener through valves at the top or inlet and to the boiler-feed pump from the bottom or outlet chamber. There is also a valved bypass from the softener directly to the boiler-feed pump suction. The inlet and outlet of the filter are connected through hand-operated gate valves to a waste pipe, to which a relief valve at the inlet

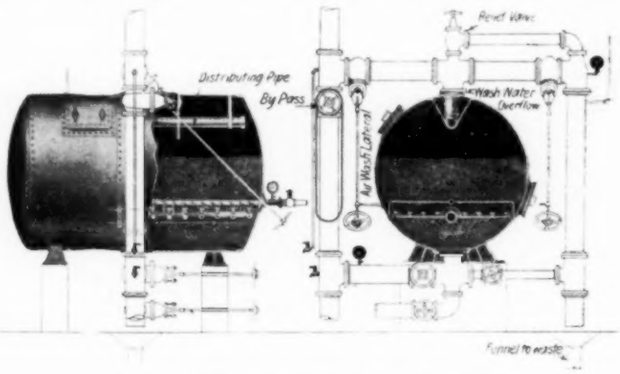


FIG. 4. HORIZONTAL SAND FILTER

also discharges. Finally, there is a connection to the outlet opening from a water supply, for back washing. A pressure gage is provided to show when the filter needs washing. Back washing is done at intervals, several times daily, the frequency depending upon the character of water. In some installations more than one filter is installed, so that it is not necessary to feed unfiltered water to the boilers while washing.

Canada's Special Overseas Trade Commission

The Canadian Trade Mission in England has been discontinued and in its stead there has been constituted the special trade commission to be known as the overseas branch associated with the trade commission office in the United Kingdom.

The duty of the overseas branch will be to make sales or purchases, or negotiate contracts for individuals or corporations. The aim will be:

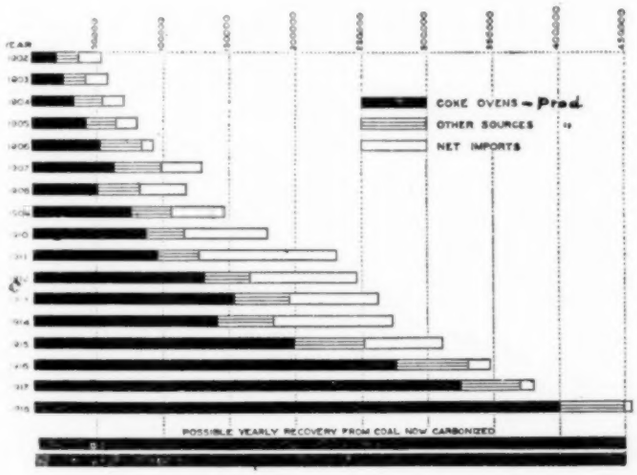
1. To provide a convenient commercial meeting place for Canadians visiting London for business purposes, where they will be made welcome and can find men ready and willing to give them advice and information.
2. To have at hand full and permanent information as to conditions of trade, openings for business, demands for Canadian supplies, and possible contracts; to facilitate conferences with business firms, manage introductions to business houses and in every legitimate way aid Canadians to extend trade.
3. Conversely, the overseas branch will be a Canadian bureau of business information as to Canadian products where persons desirous of doing business with Canadians may find ready answers, careful directions, and sound, reliable counsel.
4. To give uniform and reasonable publicity to Canadian resources and productions and opportunities.
5. To establish a wideawake and efficient commercial liaison office between Canadian producers and world buyers in London, and to that end the overseas commercial branch in London will keep in close touch with the commercial intelligence branch of the Department of Trade and Commerce.

Synopsis of Recent Chemical & Metallurgical Literature

The Utilization of Coal Tar.—A comprehensive description of the operations of The Barrett Co., by PHILIP P. SHARPLES, will be found in *Gas Age*, March 10, 1920, p. 205. After outlining the scientific blending of various tars for roofing, road-building and road-preserving purposes, the author discusses the distillation of coal tar for the production of the raw materials used in the dye and other synthetic organic industries. When the maximum amounts of these materials are recovered by distillation, there remains in the retort a hard pitch. Of this, the author says:

"Before the war it was possible to export the excess of pitch for use abroad in making fuel briquets from the soft and friable European coals. Since the scarcity of shipping closed this outlet, stocks of pitch have accumulated to an incredible extent. Truly acres of pitch surround some of the plants, and The Barrett Co. has learned to its sorrow what the English tar distiller calls 'the burden of pitch.'

"A profitable tonnage use for hard varieties of pitch is still to be found, and until found, this handicap of



AMMONIUM SULPHATE PRODUCTION, CONSUMPTION AND IMPORTS

pitch will always overshadow the profitable production of coal-tar oils. Up to date our coals have been too good to require briquetting.

"Certain small uses have been developed for carefully prepared grades. Hard pitches are used in core compounds, in the manufacture of electrodes and in making clay pigeons. All the large uses of pitch, like roofing, paving and waterproofing, call for the softer grades with many of the oils left in."

At first, gas-house tar was the only tar available. Later, water-gas tar gave promise of becoming the dominant factor, but the adoption of the coke oven by the steel industry has given the lead to coke-oven tar. During 1918, about 263,000,000 gal. of coke-oven tar was produced, while the production of all other tars (including water-gas tar) was 161,000,000 gal. Gas-house tar production is nearly stationary, while coke-oven tar production is growing by leaps and bounds with the substitution of byproduct for beehive ovens. Whether this flood of tar can all be distilled and absorbed in the growing market for coal-tar materials, or whether its value as fuel will divert some of it to that field, is a problem of the future.

In the capacity of sales agents for many of the byproduct coke plants, The Barrett Co. is interested in the use of ammonium sulphate as a fertilizer. The accompanying chart shows the production, consumption and imports of ammonium sulphate from 1902 to 1918.

The double line at the bottom of the chart represents the amount of ammonium sulphate which would be produced at the present time from the amount of coal carbonized, were it not for the loss of ammonia caused by the use of beehive ovens.

Preparation of Methyl Chloride and Methyl Bromide From Dimethyl Sulphate.—In a note presented at the March 8 meeting of the French Academy of Sciences, CH. BOULIN and L. J. SIMON describe their work on the preparation of methyl chloride and methyl bromide (*Comptes Rendus*, vol. 170, No. 10, pp. 595-597). Methyl chloride is prepared preferably by the action of 16 deg. Bé. hydrochloric acid or less advantageously of sodium chloride on dimethyl sulphate according to the equations

$$SO_2(OCH_3)_2 + HCl = SO_2(OH)(OCH_3) + CH_3Cl$$

$$SO_2(OCH_3)_2 + NaCl + Aq = SO_2(ONa)(OCH_3) + CH_3Cl + Aq$$

When using hydrochloric acid the best operating temperature is 50 deg. C. The methyl chloride obtained contains only a few thousandths of methyl oxide, and the efficiency is 90 per cent. When using sodium chloride it is necessary to first bring the solution to 60 to 65 deg. C., at which temperature the reaction starts, and then cool down to 50 deg. C. The efficiency is about 90 per cent.

For the preparation of methyl bromide they use a concentrated solution of an alkaline bromide slightly acidulated with sulphuric acid and operate at a temperature of 30 to 35 deg. C. The efficiency is 90 per cent on the basis of the dimethyl sulphate used and practically quantitative on the basis of the bromine in the bromide used.

The Production of Tin in Australia.—In most tin-mining countries the bulk of the metal is obtained from alluvial workings, and although the tin from such deposits is by no means exhausted, such is the case with most of the easily worked deposits. Economic considerations prevent the utilization of the unworked deposits, and, on the whole, the day of alluvial tin mining is on the wane. Practically all the tin mined in Bolivia, and all mined in Cornwall, comes from lode mines, but this type of mining is unpopular in Australia. There are various reasons for this, such as a large proportion of failures of lode operations due to such causes as unfavorable location, bad management, unsuitable treatment plants and inadequate scale of operations. However, with the gradual elimination of alluvial deposits as producers and the increasing demand for tin, lode tin mining will probably receive greater attention in the future. This, according to J. B. LEWIS, who writes on the subject in *Chemical Engineering and Mining Review* (Australia), is satisfactory as far as Australia is concerned, for there are a large number of occur-

rences of tin in all the states, those in Tasmania being probably the richest and largest in extent, while in Victoria there are also extensive deposits.

There are difficulties to be overcome in dealing with these large deposits, for as a rule they are of low grade and to be profitable should be worked on a large scale. In the northeast of Tasmania are several lode tin fields, those at the Blue Tier and Aroca being the most extensive. Practically the only metal in the ore is tin, other minerals such as wolframite, molybdenite and ores of copper being found in very small quantities and in few places. At one mine over a period of about ten years the average recovery was 3.42 lb. of tin oxide per ton, which indicates that the original ore contained about 4¼ per cent of tin oxide. Near the west coast of Tasmania there is a belt of country where there are found large low-grade deposits of tin, copper, silver-lead and zinc ores, the Mt. Lyell copper mine and the Mt. Bischoff tin mine being well known.

It seems probable that an increasing amount of tin may be expected from Australia when the large low-grade deposits receive the attention they deserve.

Recent Chemical & Metallurgical Patents

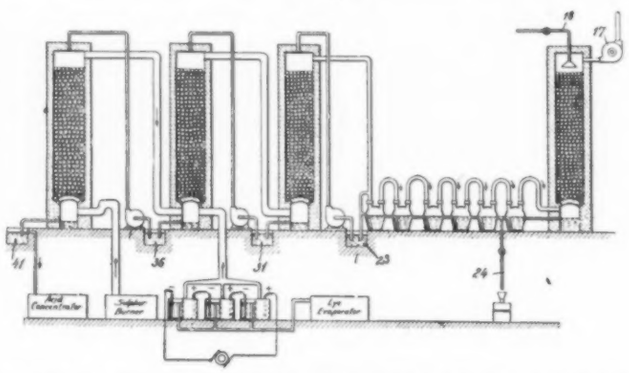
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Use of Sodium Bisulphate in the Manufacture of Ammonium Sulphate.—When sodium bisulphate is used in place of sulphuric acid in the ammonia saturators, a double salt, $Na_2SO_4(NH_4)_2SO_4 4H_2O$, is formed. GERHARD N. VIS of Paris, France, describes a cyclic process of fractional crystallization for the separation of sodium and ammonium sulphates from the double salt. By heating the double salt and ammonium sulphate with water in the proper proportions, all of the ammonium sulphate goes into solution, while part of the sodium sulphate is dehydrated and remains undissolved. This is filtered off and the mother liquor cooled to 62 deg. C., when ammonium sulphate separates with a small amount of Na_2SO_4, which may be removed by washing with saturated $(NH_4)_2SO_4$ solution. The final mother liquor is treated with more double salt and $(NH_4)_2SO_4$ to restore the original composition of the solution and the cycle repeated. Attention is directed to the fact that 100 parts of H_2O saturated with $(NH_4)_2SO_4$ at 110 deg. C. dissolve 42.2 parts of Na_2SO_4 and the separation of the double salt from the solution only commences at about 60 deg. F. Further, the solubility of $(NH_4)_2SO_4$ in 100 parts of water saturated with Na_2SO_4 decreases nearly regularly from 102 to 75 parts when the temperature is reduced from 110 to 50 deg. C. (1,332,419; March 2, 1920.)

Simultaneous Production of Sulphuric and Hydrochloric Acids.—HENRI TOBLER of Hackensack, N. J., has adapted the following reaction to large scale production:

$$SO_2 + Cl_2 + 2H_2O = H_2SO_4 + 2HCl$$

As shown in the accompanying illustration, the apparatus consists essentially of three absorption towers similar in construction to Glover towers in series with a number of hydrochloric acid tourills and a fourth Glover tower. Sulphur dioxide is produced in a sulphur burner and delivered to the first tower, where a portion of the heat is utilized in concentrating and completing the removal of hydrochloric from the sulphuric acid formed later in the process. Passing to the second tower, the gas is mixed with chlorine from electrolytic cells. The reaction is completed in the third tower and the gases are drawn through the tourills and fourth tower by a suction fan, 17. A cold-water spray admitted at 18 serves to absorb the last portions of hydrochloric acid gas. Substantially pure hydrochloric acid is drawn



TOBLER APPARATUS FOR SIMULTANEOUS PRODUCTION OF SULPHURIC AND HYDROCHLORIC ACIDS

off through pipe 24, while the mixture of HCl and H_2SO_4 is pumped to the tops of the first three towers in succession. The mixed acid in sump 23 has a gravity of about 23 deg. Bé. After passing through the third tower, the liquid in sump 31 is about 36 deg. Bé. The proportion of H_2SO_4 increases steadily in the liquid, sump 36 containing 50 deg. Bé. acid and sump 41, 60 deg. Bé. H_2SO_4 containing practically no HCl. This acid is removed for further concentration to 66 deg. Bé. The products of this plant are HCl, H_2SO_4 and NaOH. The latter compound is obtained as a byproduct from the electrolytic cells which furnish chlorine for the process. (1,332,581; assigned to American Bromine Co., of Maywood, N. J.; March 2, 1920.)

Australian Patents

Complete specifications of Australian patents may be obtained from the Government Printer, Melbourne, one shilling each.

Preserving India Rubber.—To prevent the oxidation of rubber goods, the enzymes are destroyed by the application of a 10 per cent solution of ammonia containing about 0.3 per cent of a saponaceous substance such as sodium oleate, laurate and cresylic acid, carbolic acid or other antiseptic substance which will not precipitate the soapy material. The solution is applied to the latex, or to flexible rubber goods by immersion or by repeated superficial application. (Aust. Pat. 3,364; F. E. STOWE, New South Wales. Feb. 10, 1920.)

Extracting Copper.—To precipitate copper from a cuprous solution the latter is passed through a series of tanks arranged in terraced fashion and connected by launders. The tanks contain charcoal placed on perforated plates. The precipitated copper is separated from the charcoal by washing. The tanks may be divided into compartments by vertical partitions over and under which the solution passes from the inlet to the outlet launder. (Aust. Pat. 9,254; J. H. FLEMING, New Zealand. Dec. 23, 1919.)

Current Events
in the Chemical and Metallurgical Industries

Reorganization of Research in Applied Chemistry at M. I. T.

At a recent dinner tendered to nineteen members of the Research Laboratory of Applied Chemistry staff, Dr. William H. Walker made public his resignation as director of this laboratory. He was compelled to do this because of the pressure of duties in connection with his position as director of the Division of Industrial Co-operation and Research.

Coincident with the above announcement was the appointment of Prof. Robert E. Wilson, formerly assistant director, to the position of director. In view of the enlarged scope of laboratory work, two assistant directors were also appointed, Dr. C. S. Venable—in charge of organic problems, and Dr. L. W. Parsons—in charge of inorganic problems.

Prof. R. E. Wilson, who is taking the position left vacant by Dr. Walker's resignation, was graduated from the University of Wooster, Ohio, in 1914 and from Course X at the Institute in 1916. From that time until the present he has had broad experience in research work. During the spring and summer of 1915 he worked in the Research Laboratory of Physical Chemistry, and the following year was engaged in research for the General Electric Co. at Schenectady. He returned to the Institute as research associate in applied chemistry in the fall of 1916, but left in the spring of 1917 to act in the capacity of consulting chemical engineer in the Bureau of Mines. Under the direction of Prof. W. K. Lewis, he organized the first research laboratory for poison gas work.

When this work was expanded and moved from Pittsburgh to Washington, he was placed in charge of the smoke and absorbent units and was commissioned Captain and later Major in the Chemical Warfare Service. Upon completing his army work a year ago, he refused several important industrial research positions to take up his work at the Institute.

Dr. C. S. Venable was graduated from the University of North Carolina and received a Master's degree in 1911. He received his Ph.D. in organic chemistry from the Institute in 1917. As a Captain in the Chemical Warfare Service, he had responsible charge of much research and development work on toxic gases. He joined the Research Laboratory in April, 1919.

Dr. L. W. Parsons is a graduate of Course V, chemistry, in the class of 1913, and served as assistant in analytical chemistry for one year. From 1914 to 1916 he served as a teaching fellow at Harvard, and a year later received his Ph.D. from that institution. He served throughout most of the war as a Captain in the Chemical Warfare Service, aiding in the directing of research work on absorbents. He returned to the Institute as research associate in March, 1919.

The Research Laboratory was first organized in 1907 by Dr. Walker and under his direction has successfully solved a large number of industrial problems, as well as publishing twenty papers of general scientific interest. During the period of the war, the laboratory was closed, but was re-opened about a year ago. Starting then with seven members, the laboratory has grown rapidly until it now numbers fifteen full time workers, and several part time workers. The laboratory is now conducting a wide number of problems for such concerns as the Goodyear Tire & Rubber Co., Vacuum Oil Co., the National Electrolytic Co. and the National Tube Co.

Fixed Nitrogen Corporation Bill

With Senator Gronna's announcement on the floor of the Senate of views unmistakably in favor of the fixed nitrogen corporation bill, it is apparent that the measure soon will be reported favorably by the Senate Committee on Agriculture. Based largely on the assumption that Senator Gronna was not particularly friendly to the bill, some of those opposing the measure hoped that no prompt report on the bill would be forthcoming.

The determined way in which the Senate rejected the amendment to the fortifications appropriation bill, which would have curtailed expenditures at Muscle Shoals, is an indication of an overwhelming sentiment in favor of operating the plant and continuing the work.

Senator Underwood in an extended speech declared that "there are certain great interests in this country that have made up their minds to kill this plant." He declared that Senator Smoot, who was urging the amendment, had been misled on the proposition. Resentment was shown because the suggestion which resulted in the amendment came from Representative Graham. The Senate oftentimes does not take kindly to such suggestions from members of the House. In addition, in this case, many members of the Senate have no high opinions of the soundness of many of the conclusions which have been drawn by the Graham committee.

Dye Bill Before Senate

Consideration of the dyestuff bill began in the Senate May 1. Senator Frelinghuysen addressed the Senate at length, urging the passage of the bill, which he places second in importance to the Army and Navy bills, providing for the national defense. It is anticipated that extended debate will result before the measure can be passed.

Société de Chimie Industrielle

A meeting of the New York section of the Société de Chimie Industrielle will be held in Rumford Hall, 50 East 41st St., on Friday evening, May 14, beginning promptly at 8:30 o'clock. An informal dinner will be held at 6.30 P. M. Visitors are invited.

The program will be as follows:

"Commercial Relations Between France and the United States," the Hon. Maurice Casenave, chairman French High Commission to the United States; "Condition of Chemical Industry in the United States Before the War," Joseph H. Choate, general counsel of the Chemical Foundation, Inc.; election of officers, general business, social gathering and reception.

Aid for Austrian Engineers

There have been referred to Engineering Council by some of its member societies several appeals for aid to Austrian engineers. Consquently, at its meeting April 29, Council voted to instruct its secretary to prepare an appeal and transmit it to the member societies with request for publication.

A letter from the Austrian Society of Engineers in Private Practice is representative of the appeals for food:

> Fellow Craftsmen:—Austria is hungry! The supply of foodstuffs available is less than half enough. Hunger has lowered the standard of our work and has so undermined us physically that we can do nothing toward improving ourselves. We turn to America as the only state which can help us in our distress; the only nation in the world that can keep us from starving.
>
> There are 1,000 members of our organization in Austria in the various branches of engineers, such as electrical, mechanical, civil, mining, architectural and chemical. Approximately half of our members are wholly without employment, but even those who have work receive only on an average 1,500 kronen a month, a little more than $5.
>
> Through the American Relief Administration a means is provided for furnishing us with food. Americans can buy food drafts at any bank in America and send them to us by registered mail. On presentation of these drafts in Austria, the American Relief Administration Warehouse will deliver to us stipulated quantities and kinds of American food shipped to Austria for that purpose.
>
> You are our professional brothers—and we ask you to stand by us in our hour of need. We appeal to you, fellow craftsmen across the sea, to send us food drafts lest we starve!
>
> For further information apply to the American Relief Administration, 115 Broadway, New York, or to your own or the nearest bank.

There are also appeals for technical literature, such as books and back numbers of technical magazines issued since the middle of 1914.

Purple Dye From Shellfish

On the Pacific coast of Costa Rica, especially in the region about Cocos Bay, there abounds a kind of shellfish called the "nacascol," from which a fine purple color is obtained. So far no way has been found for preserving this dye, and the industry has remained in the hands of the few old people who take the trouble to dye a few ounces of thread every summer. The process is very simple. On picking up the shell from the beach or detaching it from a boulder, the gatherer blows her breath into it, whereupon a few drops of a greenish liquor ooze out. This liquor is collected in a clamshell, and after a sufficient quantity has been collected the thread is passed through it, soon after assuming, on exposure to the sunlight, a beautiful purple color, which is absolutely fast after it has turned purple. It is thought possible that the dye turns fast only on exposure to the air and that the liquor could be preserved by keeping the air away from it. There is little doubt that this industry of dyeing thread could be extended to much greater proportions if an extensive demand at good prices could be found for the dyestuff.

Fire in National Lead Co.'s Plant

On Sunday, May 2, fire broke out in the plant of the National Lead Co. on Staten Island. Some of the corroding stacks were burned and part of a small mill. The loss is estimated at between $50,000 and $75,000, fully covered by insurance.

Fellowships at the University of Utah

Seven teaching fellowships have been provided in the department of chemistry by the University of Utah for the academic year starting the fall of 1920. Dr. W. D. Bonner, in charge, has outlined an attractive series of investigations upon oil shales and other Utah raw materials.

American Cotton Seed and Cottonseed Products

Preliminary figures issued by the Bureau of Census show that 3,894,408 tons of cotton seed was received at the mills in the United States during the period from Aug. 1, 1919, to March 31, 1920, as compared with 4,051,797 tons during the corresponding period of 1919. These figures do not include 23,725 tons and 40,438 tons on hand Aug. 1, nor 151,650 tons and 113,869 tons reshipped or destroyed for 1920 and 1919, respectively. The amount of cotton seed crushed during the eight-month period was 3.704,978 tons in 1920, and 3.785,626 tons in 1919.

Imports of cottonseed products for the eight months ended March 31, 1920, amounted to 16,672,391 lb., and to 11,194,336 lb. during the corresponding period of the preceding year. Exports during this period consisted of 106,676,290 lb. of oil, 226,281 tons of cake and meal and 33,978 running bales of linters in 1920, as compared with 106,403,221 lb. of oil, 87,503 tons of cake and meal and 64,095 running bales of linters in 1919.

New Protection Against Deadly Gases

A new means of detecting the presence of carbon monoxide, which is the cause of many deaths in mines, has been perfected by Prof. C. R. Hoover. The device was invented by him in his chemical laboratory at Wesleyan University, Middletown, Conn. It is a delicate instrument which records not only the presence of the monoxide but also the quantity of it in the air. It consists of a small glass tube filled with a mixture of an iodine salt, pumice stone and fuming sulphuric acid. When impure air is admitted to the tube the contents turn green, the depth of the color indicating the percentage of CO.

The detector can be lowered by a string into shafts and then withdrawn for examination before anyone is permitted to enter. It is of special value in the iron and steel industries, in gas manufacture, for fire departments and in mine rescue work.

Mexican Directory of Domestic and Foreign Industries

The Mexican Confederation of Industrial Chambers has decided to publish a registry of foreign industries, having already in advanced preparation a registry of Mexican industries, and will furnish to foreign manufacturers and capitalists, without charge, information requested by them, unless, to obtain such information, it should be necessary to employ experts. It is requested that chambers of commerce, manufacturers' associations and similar organizations in the United States communicate directly with the Mexican organization, sending such data as will serve to co-operate in bringing the commercial and industrial interests of the two nations into mutually advantageous relations. The name of the Mexican body is Confederacion de Camaras Industriales de los Estados Mexicanos, Apartado 28, Mexico, D. F.

Carborundum Refractories to Be Made at Perth Amboy

The Carborundum Co., of Niagara Falls, N. Y., has acquired from the Alien Property Custodian the plant formerly owned and operated by the Didier-March Co. at Perth Amboy, N. J. The plant will be taken over at once and converted to the manufacture of a complete line of refractories.

The principal business of the Didier-March Co. was the manufacture of special refractory clay products, and practically all of its equipment will be utilized. The plant is located on a site of twenty-four acres fronting on the Raritan River and is well provided with wharfing facilities and railroad connections. It consists of a modern clay-working plant with a capacity of over one hundred tons per day and covers a floor space of about 300,000 sq.ft. The buildings are of substantial brick, steel and concrete construction, and there are also included office buildings, laboratories and ample housing facilities for employees. In addition to this property, the company acquires sixty acres of high-grade fire-clay lands at Bonhamton and a clay-excavating plant in operation.

The plant will be used exclusively for the manufacture of carborundum refractories. These are made in four regular grades, in addition to which special mixes are utilized in the production of saggers. These grades are known as Carbofrax "A," "B" and "C," and Refrax. All of the standard shapes in which fire-clay or silica brick are made can be produced in any of the grades, in addition to which practically any special shape, including tile, muffles and saggers, can be made in any of the three Carbofrax grades only.

Refractories made in any of the three Carbofrax grades are composed of over 90 per cent silicon carbide to which small percentages of highly refractory materials are added to facilitate binding. High refractibility is, therefore, maintained due to the fact that silicon carbide cannot be melted, and is decomposed into silicon vapor and graphite only above 4,000 deg. F.

In addition to the regular line of made-up refractories, the new plant at Perth Amboy will produce a complete line of high-grade refractory cements. It has not been found possible to produce a refractory cement which will cover all conditions, consequently ten special cements have been developed and these have been found to cover a great variety of requirements.

Large Canadian Chemical Company Organized

Chemical Products, Ltd., has secured the Trenton, Ont., plant of British Chemicals, Ltd., which was operated during the war for the production of acids and explosives. The new company is prepared to manufacture 75,000 tons of acid phosphate per year, and expects to engage in the production of acids, both sulphuric and nitric.

The plant has been re-arranged into four units where the following operations will be undertaken in a very large way in charge of A. H. C. Heitman:

Plant 1. Production of sulphuric acid and acid phosphate; production of nitric acid for general purposes.

Plant 2. Refined nitrate of soda, magnesium sulphate.

Plant 3. Salicylates and derivatives.

Plant 4. Ammonia and coke-oven byproducts.

Tennessee Copper & Chemical Corporation's Deficit

The largest lead chamber sulphuric acid plant in the world is located at Copper Hill, Tenn., and is operated by the Tennessee Copper & Chemical Corporation. It was erected to abate the nuisance caused by the great quantities of SO_2 produced during the smelting of the low-grade sulphide ores. It has a capacity of about 350,000 tons of 60 deg. acid per year.[1]

A deficit was returned for the last fiscal year, due largely to the fact that the acid makers were working under a 10-yr. contract with the International Agricultural Corporation for the entire output. An agreement which was attractive at the outset is evidently not so profitable at present. Fortunately for the Tennessee corporation, but unfortunately for the Agricultural company this contract expires on Dec. 31, 1920. It is understood that the Tennessee Copper & Chemical Corporation has already made tentative future arrangements with several fertilizer companies in which higher prices for 50 per cent of its acid will be obtained. This will leave a quantity of acid which can either be sold in the open market or utilized by the corporation itself in the manufacture of acid phosphate, which field it has recently entered.

The Southern Agricultural Corporation, a new company owned and controlled by the Tennessee Copper & Chemical Corporation, has been formed for the manufacture of fertilizer, and a new 100,000-ton plant is being erected at Atlanta, Ga. A phosphate rock property near Bartow, Fla., has also been acquired recently.

St. Louis Coke & Chemical Co.

A new plant being constructed in St. Louis for the St. Louis Coke & Chemical Co. occupies about 220 acres and will be served by ten miles of trackage facilities. On the site is being erected a 500-ton blast furnace which will be used for the manufacture of pig iron. The metal will not be cast into pigs, but will be conveyed in molten form in ladle cars to the plant of the National Stamping & Enameling Co., which adjoins the property.

Iron ore will be brought in by car and barge from the Minnesota districts and approximately 2,000 tons of Illinois coal will be carbonized daily. There will be eighty of the Robert type of ovens for the manufacture of coke. These ovens are 13 in. wide, 14 ft. high and 42 ft. long. The various carbonization products will be divided as follows: 1,400 tons of coke, 20,000 gal. of tar, 10,000,000 cu.ft. of gas, 6,000 gal. of motor fuel and 6,000 lb. of ammonium sulphate. All the byproducts with the exception of the ammonium sulphate will be utilized by the company.

Du Pont Company to Manufacture Artificial Silk

The du Pont company and the Comptoir des Textiles Artificiels, of Paris, France, have entered into an agreement whereby a new company will be formed in America for the manufacture of artificial silk. Announcement is made that the du Pont Fibersilk Co., with a capitalization of $4,000,000, has been organized.

The Comptoir des Textiles Artificiels controls practically all of the largest artificial silk plants in Europe.

It is anticipated that the plant will be in full operation within a year.

[1]For description of this plant see CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, p. 404, Sept. 25, 1918.

Annual Reports of Metallurgical Companies

New Cornelia Copper Co.

Market conditions were unsatisfactory throughout the year 1919 and the company was unable to market a large quantity of copper, notwithstanding a considerable curtailment of production. This adversely affected the income account and increased the amount of copper on hand. The operating costs, however, were satisfactory. At the plant at Ajo 29,640,211 lb. of electrolytic copper was produced and 6,368,952 lb. shipped as cement copper. Sales of copper during the year amounted to about 30,000,000 lb., of which but 23,000,000 lb. was delivered.

The leaching and the electrolytic plants have worked satisfactorily. The hard lead anodes after thirty months service show very little corrosion. The leaching system has also worked satisfactorily. An inspection of the lead linings of the leaching tanks and the pumps shows that there has been no appreciable wear or deterioration on these installations. A six-compartment settling tank which will have capacity to take care of the slimes of the neutral solution before going to the sulphur dioxide reduction towers and the reduced iron solution after passing the towers is being installed. This will permit of the use for leaching of a tank that has been used as a settling tank and prevent the plugging of the reduction towers with slimes.

A 500-ton flotation mill was completed and put in operation late in August and 14,024 tons of sulphide ore was treated in the mill. This ore ran 1.275 per cent sulphide copper and 0.038 per cent oxide copper. A tailing was produced carrying 0.203 per cent sulphide and 0.028 per cent oxide copper, which represents a total recovery of 83.61 per cent. The ratio of concentration was 14.767 to 1.

Calumet & Arizona Mining Co.

The report of the Calumet and Arizona Mining Co., for the year ended Dec. 31, 1919, shows a production of 50,000,000 and sales amounting to 47,000,000 lb. of copper and a net income of $524,416 after charging off $1,381,948 to ore depletion. The year opened with a heavy balance of unsold copper in the hands of producers, which necessitated a curtailment in production. The last quarter of the year showed improvement in the demand for copper, and record sales were made in December for 1920 delivery. The average daily wages paid at the mines increased from $5.37 to $5.52.

During 1919 the smelter at Douglas treated 701,450 dry tons of ore, compared with 850,894 dry tons in 1918; the production for 1919 was about 56 per cent capacity, the decrease being largely in the blast-furnace department. Reduction in the blast-furnace department was made on account of the lower operating cost of the reverberatories, the decreased amount of oxide ore received and the gradual changing of all ores to a more desirable reverberatory charge. The roaster plant operated at full capacity the entire year.

On account of the curtailment of operations of the New Cornelia Copper Co., which consumes the largest portion of the acid produced by the acid plant, this plant was operated at about two-thirds capacity, producing 48,600 tons of 60 deg. Bé. acid compared with 67,100 tons in 1918.

On account of the deterioration of the tile lining inside the stack of the roaster department, it was necessary to remove the top 120 ft. of steel and all of the tile lining and to replace the old steel with new and completely reline the stack with acid-proof high-silica brick. When this is completed the roaster department will be in good condition. During the shut-down of the acid plant the towers of the acid plant were cleaned, putting this plant in good operating condition.

Judge Mining & Smelting Co.

Labor conditions in the Park City district and the unsatisfactory conditions of the zinc market during 1919 adversely affected the operations of the Judge Mining & Smelting Co. During the first part of the year there was an acute shortage of labor, and as a consequence it was impossible to obtain proper efficiency from the men obtainable. Agitation fostered by the Industrial Workers of the World resulted in a complete stoppage of operations for two months. Since the first of the present year, however, conditions have improved, better prices have been obtained for zinc and the surplus zinc on hand has begun to move.

For 1919 the metal content of all ores sold was: Silver, 410,307 oz.; lead, 6,989,908 lb.; copper, 276,926 lb.; gold, 462 oz.; zinc, 262,760 lb.

The electrolytic zinc plant operated for the first four months of 1919, when operations ceased because of the labor strike. Advantage was taken of the shutdown to carry on experimental work for the purpose of increasing the recovery of metal and to develop a process for the recovery of byproducts. The experimental work has been completed and the necessary changes in the plant have been made. Operation of the zinc plant was resumed in January, 1920, and zinc is now being produced of 99.95 per cent purity.

American Smelting & Refining Co.

The reconstruction period of 1919 adversely affected the business of smelting and refining of metals in the following important respects: (1) The reduction of mine production and a proportionate curtailment of operations of the smelters and refineries, which increased the cost of operation per ton treated. This made necessary the reduction of forces and readjustment of methods. (2) The cessation of demand for metals locked up the company's liquid capital and increased greatly the metal carried in stock. (3) The company's policy of accepting long-time contracts, many of which were entered into in the early stages of or prior to the war, became burdensome due to the increased cost of labor, fuels and supplies and because of the decreased efficiency of labor and higher freight rates. Average wages per 8-hr. day increased from $3.96 to $4.34.

The situation made necessary drastic measures to decrease expenditures. These were taken early in the year, and the beneficial results are shown in the net earnings, which for the first six months of 1919 were $2,149,159.66 and for the last six months of 1919 were $3,446,424.91.

The rising price of silver turned attention particularly to Mexico, and efforts were made to develop maximum output. Production was interrupted by the Villa activity in the late spring. All smelters in Mexico were in operation at the close of the year.

In order to increase ore production a substantial interest was purchased in the Premier mine, in British Columbia, and other options have been taken on several properties in that country. Over 90 per cent of the

Sabines Coal Co. has been acquired during the year. This property is located about one hundred miles from the Mexican border, and development will enable the Mexican smelters to be supplied with a satisfactory quality of coke at a lower cost.

A comparison showing the receipts from sale of metals and the metal production for the years 1918 and 1919 is given below.

RECEIPTS

From Sales of Metals:	1919	1918
Gold	$44,777,926.70	$40,624,998.17
Silver	64,105,415.60	54,547,364.28
Lead	21,573,831.43	34,955,070.42
Copper	81,281,842.45	208,840,411.45
Zinc	2,797,444.95	4,544,170.26
Tin	8,537,899.83	14,635,931.77
Other metals	2,032,790.26	1,912,540.40
Total	$225,107,151.22	$360,060,486.75

METAL PRODUCTS

	1919	1918
Ounces of gold produced	2,191,041	1,994,015
Ounces of silver produced	78,200,298	72,572,506
Ounces of platinum and palladium produced	1,824	1,516
Tons lead produced	208,439	260,192
Pounds copper produced	705,676,000	868,540,000
Pounds spelter produced	33,375,301	41,238,000
Pounds nickel produced	662,637	626,085
Pounds tin produced	15,340,000	19,868,000
Pounds sulphuric acid produced	40,362,000	87,338,000
Pounds arsenic produced	9,359,541	7,837,063
Pounds copper sulphate produced	3,675,499	5,164,000
Pounds byproduct metal produced	884,438	1,870,662

The company paid $6,681,242.25 in dividends, a decrease of $921,421.50 from 1918, practically all of this being on the common stock.

Portland Gold Mining Co.

The effect of the diminished purchasing power of gold is reflected in the annual report of the Portland Gold Mining Co. Operations during 1919 resulted in profits from mining and milling of $224,000, which, together with revenue from other sources, brought the net income to $234,636. Depreciation of mine and mill equipment was charged off to the extent of $174,666 and mine depletion to $146,313, resulting in a net loss to surplus of $92,817. Dividends of $240,000 were paid in 1919, the surplus for Jan. 1, 1920, being $819,531, a decrease of $332,817 from Jan. 1, 1919. Adverse conditions brought about by the war are still in effect in the Cripple Creek district.

Before the war ore of a value of $2 a ton was treated with greater profit than $3 ore yields at the present time, notwithstanding the many economies instituted during the war period.

Mount Morgan Gold Mining Co., Ltd.

The Mount Morgan Gold Mining Co., Ltd., of Queensland, Australia, for the six months ended Nov. 30, 1919, smelted 90,475 tons of ore and concentrate, recovered 2,749 tons of copper and 41,191 oz. of gold, and showed a surplus over expenditures of £43,333. Production of the mines was reduced about 40,000 tons below normal due to an epidemic of influenza and to a stoppage of operation brought about by the seamen's strike. Experimental work on leaching Mount Morgan ore in a unit treating one ton of calcines per 24 hr. gave satisfactory indications as to the recovery of copper, but gold extractions have not been so completely and satisfactorily demonstrated. With a view of obtaining more complete data a 10-ton unit is now being installed. This unit will, in addition to leaching copper from the calcines, also treat the residues for gold by chlorination.

Scarcity of German Dyes

In January, a committee from the British Color Users' Association of Manchester was sent to Germany to investigate the dyestuff situation and to report upon the available stocks now held in that country. This committee, after carefully examining the situation in Germany and after holding a number of conferences with leading German color manufacturers, has issued its report, in which it first states that it found the stocks of dyestuffs available in Germany to be very small indeed. It ascertained that very little, if any, manufacturing of dyestuffs was being carried on, owing principally to the shortage of raw materials and fuel, although conditions were slightly better in the sector at present under British occupation, where manufacturers were succeeding in turning out small quantities of dyes. It found that in some parts of Germany numerous foreign buyers had been trying to purchase any surplus stocks that might be had after the necessary 50 per cent had been set aside for the purposes of the Reparation Commission, but with no great success.

This British commission decided on a policy of buying on commercial lines on behalf of the whole body of color users, and bought for immediate export to Great Britain 140 tons of German dyestuffs for the approximate sum of £191,720 ($933,000 at normal exchange for the pound sterling) for the lot. Of course, the committee would have been better pleased if it could have secured a much larger quantity, but it found this to be impossible. The committee, however, entered into tentative negotiations with sundry manufacturers, and hopes, by reason of these, to receive larger and more varied shipments of dyes from Germany in the near future. Catalogues of all dyes already purchased are being prepared for the use of British consumers, and the committee has stated that, in its opinion, the best means whereby an adequate supply of dyes can be obtained will be by an organized plan for the purchase of all possible supplies wherever obtainable. Only by some concerted and well-organized effort can the British dye users expect to obtain in the future such stocks of European dyes as will enable them to meet all their requirements.

Finer Colors Lacking in British Dyes

There seems a definite fear among the color-using trades of the United Kingdom lest the British dye industry concentrate on the production of the commoner kinds of dyes to the neglect of the finer qualities and a wide range of varieties.

It is claimed that hundreds of dyes made in Germany are not being manufactured in Britain, and while all these are not essential dyes, they indicate that there is a far wider range of production in the German dye industry. British color users complain that the dye industry in Britain is a virtual monopoly, and is not paying sufficient attention to the requirements of the color-using trades, particularly in the matter of fine dyes.

It is fully admitted that many chemicals, never before manufactured, are being produced in Britain, but many more remain to be dealt with, as all the synthetic chemicals, whether dyes, drugs, etc., are associated in manufacture. This view receives some support from the recent Board of Trade order prohibiting export from the United Kingdom of all coal-tar products which form the basis of dyes and most chemicals.

Notice to Engineering Societies

On June 3 and 4, 1920, there will be a meeting at Washington of the Joint Conference Committee of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers to consider plans for organizing a national engineering organization.

The Joint Conference Committee has twice convened, the first meeting on Aug. 13, 14 and 15 and the second Sept. 15, 16 and 17 in 1919. The results of these meetings were published in a report, which was favorably acted upon by the governing boards of the several societies, and resolutions were adopted directing the committee to call a meeting of the engineering organizations of the United States for an organizing conference and to establish the proposed organization.

Any engineering society or organization not a branch of a national engineering society is eligible for membership in the organizing conference. Full information as to credentials may be had from the committee by addressing it at 29 West 39th St., New York.

India's 1919-20 Cotton Crop

The Indian Department of Statistics has issued its final memorandum on the acreage and yield of the 1919-20 cotton crop.

The total area reported is 23,063,000 acres—about 10 per cent more than the revised total for 1918-19. The estimated yield is 5,845,000 bales of 400 lb. each—47 per cent more than in the preceding year. Of the total yield Oomras represent 48 per cent, Bengal-Sind 23 per cent, Dholleras 9 per cent, Coompta-Dharwars and Broach 5 per cent each, Tinnevellys, Salems, and Cambodias 4 per cent, and Northerns and Westerns 3 per cent.

American Purchase of Bolivian Petroleum Deposits

A large tract of petroleum land held by Chilean capital is said to have been acquired by an American in Chile for £750,000. The center of the deposits is in the vicinity of Santa Cruz. It has been announced by the new petroleum interests that a petition will be submitted to the Bolivian Government for a concession to construct a railway line from Santa Cruz to Formosa, in northern Argentina, the construction to be facilitated by grants of government lands.

Must Label Wood Alcohol Products Poison

As a further means of protecting the general public against the dangers in the use of wood alcohol, the laws of the State of Massachusetts have been so amended that such articles as bay rum, toilet water, cosmetics, and drugs containing wood alcohol, must be labeled "Poison, for external use only." It is expected that this example will be followed by other states.

Freight Rates on Vegetable Oils

A proposition is before the Transcontinental Freight Bureau to restrict to the direct lines the application of rates on vegetable oils from the Pacific Coast to eastern destinations. At the present time these rates apply via practically all routes and transit privileges and are authorized in southwestern states, which will be greatly restricted if the proposition carries.

Book Reviews

MICROSCOPIC DETERMINATION OF ORE MINERALS. By *W. Myron Davy* and *C. Mason Farnham*. Thumb-indexed; cloth, 6 x 9; pp. 154, illus. New York: McGraw-Hill Book Co., 1920. Price, $2.50.

Although the compound microscope has been extensively utilized for opaque mineral classification since the appearance of William Campbell's epoch-marking paper in 1906, Joseph Murdoch's "Microscopical Determination of the Opaque Minerals," published in 1916, has been the only comprehensive manual or textbook available on the subject.

It is to be expected that a new branch of science will at first develop rather rapidly, that new ideas will be adopted, and that new methods will be originated. That this has been true of "Mineragraphy," the name adopted by Messrs. Davy and Farnham to designate the subject on which they have written, is unquestionable; and these authors have described in their "Microscopic Determination of Ore Minerals" the new technique and criteria that have been found most useful in several laboratories.

The book is not a rehash or an adaptation of Murdoch's work, but differs therefrom in many important particulars. For instance, the determinative tables in the new book are based primarily on micro-chemical tests instead of upon color, the basis of Murdoch's tables. Davy and Farnham use only six chemical reagents, while Murdoch used seventeen; and the new book gives some data on streaks and cleavages which are not mentioned in Murdoch's work. Davy and Farnham also give in detail simple methods for testing the electrical conductivity and the electro-potential of minerals in polished sections, and describe the use of electrolysis to etch and bring out the structure of such minerals. Finally, they have included a section on standard blowpipe and inorganic qualitative chemical tests.

Investigators familiar with Murdoch's book and who use the new work may miss a few features that they have found useful; but careful study of the new book indicates that its authors have simplified the subject, and have endeavored to eliminate the personal equation.

Although determinative tables and the necessary preliminary explanations fill most of the volume, one chapter is devoted to a very lucid explanation of the technique of polishing and examining specimens, while another treats of the photo-micrography of polished sections.

The most evident weakness of the book is the inadequacy and even incorrectness of the non-microscopic data offered. It is doubtless very difficult to decide where to draw the line, so the almost complete lack of crystallographic information may perhaps be condoned. It is not so easy, however, to overlook actual errors, such, for example, as the statements that the streak of pyrite is greenish to brownish-black (instead of just black), that of enargite is sometimes grayish (instead of black), and that of sphalerite is "pale (what?) to colorless." The experienced mineralogist will also be surprised to find the cleavage of alabandite described as *perfect* cubic, this being the same term applied, and properly so, to galena. He will further search in vain, for instance, for mention of the red streak often shown by tennantite, or the greenish streak on glazed paper or porcelain so characteristic of molybdenite. Finally, he may wonder why orpiment, realgar and many other translucent or transparent minerals of non-metallic luster are described, while vanadinite, pyromorphite, wulfenite, scheelite, monazite and other important ore minerals are omitted.

It is undeniable, however, that the defects or inconsistencies criticized detract little from the usefulness of the book as a guide to the *microscopic* classification of most ore minerals, and that, considered as a whole, the volume is admirably adapted to its purpose. It forms a welcome addition to the literature of "mineragraphy" or mineralography" (Murdoch), and should be owned and used by everyone interested in this fascinating and useful science.

G. M. BUTLER.

Personal

WILLIAM C. DOWD has resigned as chemist of the American Smelting & Refining Co., Pueblo, Col., to accept the position of chief chemist of the Austin plant of the American Radiator Co., Buffalo, N. Y.

Dr. H. N. HOLMES of Oberlin gave a series of three lectures before the California Section of the American Chemical Society. The first lecture, on "Emulsions," was given at the Chemistry Building, Stanford University, April 22; the second, on "Gels," on April 23 at the University of California. On the evening of April 24 Dr. Holmes lectured on "The Industrial Application of Colloid Chemistry" at the Chamber of Commerce rooms, San Francisco.

DAVID F. HOUSTON, Secretary of the Treasury, before the Chicago Chamber of Commerce, on April 23, discussed the nation's problems and the duty of Americans.

J. F. JOHNSON, formerly with the Procter & Gamble Co., Ivorydale, Ohio, is now chief chemist of the Lever Bros. Co., Cambridge, Mass.

THOMAS J. KEENAN, secretary of the T.A.P.P.I., has resigned as editor of *Paper* and is now located at Room 1102, 18 East 41st St., New York City.

ALEXANDER M. MACMILLAN, one of the head chemists in the Customs Inland Revenue Laboratory, Ottawa, Canada, has resigned, to enter a manufacturing concern.

Prof. E. G. MAHIN, of Purdue University, presented a paper on "Non-Metallic Inclusions in Steel" before the Indiana Section of the American Chemical Society on May 8.

Dr. VAN H. MANNING recently tendered his resignation as director of the Bureau of Mines, effective June 1, and is to become director of research with the recently organized American Petroleum Institute. Dr. F. G. COTTRELL succeeds him as director.

HARRY H. MERRICK was elected president of the Mississippi Valley Association in St. Louis, April 21.

Dr. F. S. MORTIMER, secretary of the Iowa Section of the American Chemical Society, has accepted a position on the staff of the National Aniline & Chemical Co., Buffalo, N. Y.

Prof. W. A. NOYES, of the University of Illinois, Urbana, Ill., addressed the meeting of the Chemical Society of Washington, D. C., on April 28. His subject was "Foundations of Chemical Development."

L. B. SHIPLEY, formerly chemist and technical representative in matters pertaining to coal-tar heavy oils for The Barrett Co., has accepted a similar position with Bernuth Lembcke Co., Inc., New York City.

LEON R. WHITCOMB has resigned as chemical engineer with Hill & Ferguson, New York City, to accept a position with the Refinite Co., Omaha, Neb.

Obituary

SAMUEL T. MORGAN, president of the Virginia-Carolina Chemical Co., who was well known in the fertilizer field, died at his home in Richmond, Va., on April 16.

I. FRANK STONE, formerly president of the National Aniline & Chemical Co. and one of the leading manufacturing chemists of the country, died in New York City, May 5, in his fifty-fourth year. Mr. Stone was born in Chicago and when only twenty-one years old founded there the firm of I. F. Stone, that later was changed to Stone & Ware and moved to New York City in 1897. Three years later he became head of the Schoelkopf, Hartford & Hanna Co., and in 1906 assumed the presidency of the National Aniline & Chemical Co. This last concern did much to further American chemistry after German products were cut off.

Current Market Reports

The Non-Ferrous Metal Market

New York, May 10, 1920.—The metal market has been in an unsatisfactory state for the last week, owing largely to difficulties of shipment. Tin dropped about five points. Silver continues to decline.

	Cents per Lb.
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent.	32@33
Antimony, wholesale lots	11.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	56.25
Lead, New York, spot	9.37½@9.50
Lead, E. St. Louis, spot	9.00 @ 9.12
Zinc, spot, New York	8.62½
Zinc, spot, E. St. Louis	8.25

OTHER METALS		
Silver	oz.	$1.05½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.70@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.60@1.85
Platinum	oz.	110@115
Iridium	oz.	300.00
Palladium	oz.	105@115
Mercury	75 lb.	85.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	23.00
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless high brass tubing	30.50

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	21.75@22.75
Aluminum, sheet scrap	21.25@22.50
Copper, heavy machinery comp.	13.50@14.00
Copper, heavy and wire	13.50@13.75
Copper, light and bottoms	12.25@12.75
Copper, heavy cut and crucible	14.75@15.00
Brass, heavy	7.50@8.00
Brass, light	7.00@7.50
No. 1 clean brass turnings	8.25@8.50
No. 1 comp. turnings	10.25@10.75
Lead, tea	5.25@5.40
Lead, heavy	7.00@7.25
Zinc, scrap	4.25@4.50

The Iron and Steel Market

Pittsburgh, Pa., May 7, 1920.

There has been a further and very material increase in the railroad movement as affects the iron and steel industry, but the rail strike is by no means broken. The roads have made gains, through the return of a few more of the strikers, through receiving more help from volunteers and through means multiplying for getting around the difficulty, which is chiefly that of operating the yards. The Pittsburgh & Lake Erie is conspicuous by still being able to handle scarcely any freight, while even the passenger service on that line is very meager. The effect is felt particularly in the Youngstown district, but the two other lines in that territory, the Pennsylvania and the Baltimore & Ohio, are doing better, and the district is producing at least 50 per cent as much pig iron and steel as normally. As for the Pittsburgh district, it is doing probably 90 per cent or better.

An estimate can now be made that the production of pig iron in April in the country as a whole, some districts being affected by the rail strike and some not, was at about 17 per cent lower rate than production in March. Assuming capacity at 45,000,000 gross tons per annum, March production was at 90 per cent and April production at 75 per cent, but production had been increasing, and had it not been for the rail strike April would probably have shown a gain over March. Production of steel ingots probably

declined in much the same manner as production of pig iron. The pig iron production rate now is probably about 85 per cent of capacity.

Steel Shipments Heavier

There has been a slight decrease in the embargoes, permits are granted somewhat more freely, and there are somewhat better car supplies on the whole. Considerably more has been done in the past week than in the previous week by way of moving solid trainloads of finished steel, either direct to a large consumer or to classification yards, particularly in the West, that are free to operate and can distribute single cars to various consumers. The total movement of finished steel from mills has materially increased, and in a few cases the shipments have been exceeding the current production. In general, however, steel continues to pile up in mill warehouses and yards. It can readily be seen that the distribution of steel is inequitable, some consumers being entirely shut off, and it is quite probable that some consumers, with lines of communication open, are receiving more steel than they really need.

It seems to be a fair analysis that when the rail strike is ended, as presumably it will be some time, steel will be found to be more plentiful than it was before the strike started, through consumption having been more restricted than production, and this, of course, will have a bearing upon the market in general and upon prices in particular. The market is now extremely dull. Buyers are indisposed to make forward commitments, and as to prompt deliveries, they are more likely to get deliveries on orders already placed than on orders that might be placed at this time.

Prices Easier

There have been some declines in the premiums asked for very early deliveries, in from three to six weeks, bars being available at about 3.50c., as against 4c. a few weeks ago, and plates at 3.75c., against 4c. to 4.50c. For the farther forward deliveries, in from two to four months, there are no definite price declines, although some exceptional sales have been made at special prices, but there is some softening in the market.

It is now not an uncommon view in iron and steel trade circles that industry in general is marked for an early readjustment in activity and prices, and there are not a few who welcome the change. While the experience may be uncomfortable, good results are expected. Steel producers recognize that steel demand suffers from the fact that the cost of putting steel into employment is very high, both from the high prices ruling for other commodities used in conjunction with steel, and from wages being extremely high in proportion to the service rendered, and as steel prices, except for the fancy premium prices for very early deliveries, are quite moderate compared with many other commodities, the steel industry may gain more than it loses by there being a general industrial readjustment.

The Chemical and Allied Industrial Markets

New York, May 7, 1920.

The two questions uppermost in every market at the present time and for six weeks past are: (1) Are materials obtainable at any price? and (2) At what price? There is no need to enlarge upon the difficulties of shipment. Everybody in every industry is personally acquainted with the freight tie-up.

Acetic acid, 28 per cent, is to had at prices ranging from \$3.50@\$4.50 per cwt., depending upon quantity desired, as against \$2.75@\$3.50 of pre-strike listing, while 56 per cent is firmly fixed at \$6@\$7.50 per cwt. The sensational rise on *barium chloride* which started about two months back shows no signs of breaking and producers are unable to meet the situation by accepting contracts; small quantities of this material on the spot market are quoted at \$140@\$150 per ton. *Barium sulphate*, blanc fixe, dry, is in practically the same position, with 4½@6c. prevailing, against 3@5c. per lb. of the previous report, while blanc fixe, pulp, is practically off the market, current prices ranging from \$60@\$80, as compared with \$30@\$50 per ton of a few weeks ago. *Chlorine gas* can be had in 100-lb. liquid cylinders at 9@10½c. per lb., an advance of 2c. on the pound, which has been caused by curtailment of production and the scarcity of containers. Inquiries on *bleaching powder* and *soda ash* have fallen off considerably, which points to the conclusion that buyers, both foreign and domestic, realize that the present shortage has depleted the market of everything but small quantities and are unwilling to commit themselves on the prevailing premium prices. Producers have withdrawn quotations on *glauber's salt*, as the freight tie-up has very seriously affected this item. Nominal quotations ranging from \$1.50@\$2 per cwt. have been heard for small quantities of spot material. *Caustic potash* is again falling behind and it is reported that manufacturers are sold out for months ahead. Whatever material has been available during the week sold at 30@35c. per lb.

Coal-Tar Products

Inasmuch as many of the items are unobtainable and those that are available may be had only in small quantities, it will be sufficient to state a few of the prices which are not wholly nominal. Among these are *aniline oil*, which remains at former levels of 34@45c. per lb. and *aniline salts*, at 46@50c. per lb. One large producer who is the controlling factor in the *phthalic anhydride* market steadily maintains this item at 65@75c. per lb., while *toluol* is still listed at 28@30c. on contract, with considerable quantities of this material on hand.

Naval Stores

As noted last week, the prices listed in the naval stores market are those to become effective upon arrival of material in this market. This applies particularly to all grades of *rosin*, of which shipments are expected to arrive from the South soon. Savannah is being held up by a combination of labor troubles and the difficulties in coastwise shipping.

Vegetable Oils

Linseed oil has shown considerable weakness during the week. No activity has been manifested on the part of buyers, and as a result all grades have dropped. Current quotations are: *Linseed raw*, car lots, \$1.72; *raw*, tank cars, \$1.67; *boiled*, tank cars, \$1.75 per gal.

Ores and Semi-Finished Products

Fluorspar—We are advised that 700 tons of gravel fluorspar have been sold for \$25 per net ton, f.o.b. mines southern Illinois, with no analysis guaranty, contracts reading "Fairview Washed Gravel Fluorspar." Also, 1,250 tons were sold at the same price and same shipping point with an average guaranty of 85 per cent calcium fluoride and not over 6 per cent silica, while a small tonnage was sold at the same point, with no analysis guaranty, packed in barrels, at \$37.50 per ton. Producers in this territory are not desirous of accepting contracts for acid grades of fluorspar and have refused to make any quotations on these grades. During the past few weeks the demand has become more active, but a good many of the fluorspar companies are pretty well sold. It is asserted that they are holding a certain portion of their tonnage for an expected increase in price.

Vanadium Ore—Prices of vanadium ores are usually based on the vanadium content, and at present range from \$1 to \$3 per lb. of contained vanadium. The variation depends not only on the percentage of vanadium but also on the presence of lead, copper, arsenic, molybdenum, uranium, etc., which may be difficult of separation.

Ferro-Alloys

Ferromanganese is well sustained at former levels, \$200 being asked for last half delivery, and \$230@\$250 per ton for prompt. Continuous labor difficulties dating back to early December, 1919, combined with excessively heavy demand, are responsible for present rise, which occurred in rather consistent jumps of \$10 a week, from \$115 to the the present high mark at \$250.

Spiegeleisen came up \$10 during the week, from \$63@\$65 to the current price of \$73@\$75 per gross ton.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.65 – $0.75
Acetone	lb.	$0.19 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 4.00	4.25 – 4.50
Acetic, 56 per cent	cwt.	6.50 – 7.00	8.75 – 9.00
Acetic, glacial, 99½ per cent, carboy	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.14½– .15½	.15½– .16½
Boric, powder	lb.	.14½– .15	.15 – .16
Citric	lb.	.85 – .86	1.17 – 1.18
Hydrochloric (nominal)	lb.	.07 – .08	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.13½– .14
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½– .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Nitric, 40 deg	lb.	.06 – .07	.07½– .08½
Nitric, 42 deg	lb.	.07½– .08	.08½– .09½
Oxalic, crystals	lb.	.55 – .57	.58 – .59
Phosphoric, Ortho, 50 per cent solution	lb.	.22 – .23	.24 – .25
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 18.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	–
Sulphuric, 66 deg., drums	ton	35.00 – 40.00	–
Sulphuric, 66 deg., carboys	ton	36.00 – 40.00	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys			
Tannic, U. S. P	ton	32.00 – 35.00	40.00 –
Tannic (tech.)	lb.	1.50 – 1.60	1.65 – 1.70
Tartaric, crystals	lb.	–	.60 – .90
Tungstic, per lb. of WO	lb.	–	.75 – .80
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	1.20 – 1.40
Alcohol, Methyl (nominal)	gal.	2.50 – 3.50	6.00 – 7.00
Alcohol, denatured, 188 proof (nominal)	gal.	–	–
Alcohol, denatured, 190 proof (nominal)	gal.	–	1.00 – 1.05
Alum, ammonia lump	lb.	.04½– .05	.98 – 1.02
Alum, potash lump	lb.	.07½– .08½	.05½– .06
Alum, chrome lump	lb.	.17 – .18	.09 – .09½
Aluminum sulphate, commercial (nominal)	lb.	.01½– .02	.19 – .20
Aluminum sulphate, iron free	lb.	.02½– .03	.02½– .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½– .10½	.03¼– .03¾
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.11 – .12
Ammonium carbonate, powder	lb.	.16 – .16½	.35 – .40
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.08½ – .12	–
Ammonium sulphate	lb.	.07 – .08	.08½– –
Amylacetate	gal.	–	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.13½– .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	–
Barium chloride (nominal)	ton	150.00–160.00	165.00 – 175.00
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½– .05	.05½– .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine		–	–
Calcium acetate	lb.	.85 – .90	–
Calcium carbide	cwt.	2.00 – 2.05	2.10 –
Calcium chloride, fused, lump	lb.	.04½– .04½	.04½– .05½
Calcium chloride, granulated	ton	23.00 – 25.00	30.00 – 40.00
Calcium hypochlorite(bleaching powder)	lb.	.01½– .01¾	.02 – .02½
Calcium peroxide	cwt.	4.00 – 4.25	4.35 – 5.00
Calcium phosphate, monobasic	lb.	–	1.50 – 1.70
Calcium sulphate, pure	lb.	–	.75 – .80
Carbon bisulphide	lb.	.07 – .08	.25 – .30
Carbon tetrachloride, drums	lb.	.11 – .11½	.09 – .10
Carbonyl chloride (phosgene)	lb.	–	.12 – .15½
Caustic potash (see potassium hydroxide)		–	.80 – 1.05
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	–
Chloroform	lb.	.30 – .35	.10 – .10½
Cobalt oxide	lb.	–	.36 – .38
Copperas (see iron sulphate)		–	2.00 – 2.05
Copper carbonate, green precipitate	lb.	.27 – .28	–
Copper cyanide	lb.	–	.29 – .31
Copper sulphate, crystals	lb.	.08½– .09	.65 – .70
Cream of tartar (see potassium bitartrate)		–	.09 – .09½
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	–
Glauber's salt (see sodium sulphate)		–	.60 – .80
Glycerine		–	–
Iodine, resublimed	lb.	–	.24½– .26
Iron oxide, red	lb.	4.30 – 4.35	4.40 – 4.45
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	.14 – .14½	.15 – .18
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .16
Magnesium sulphate, U. S. P	100 lb.	3.50 – 3.55	3.60 – 4.25
Magnesium sulphate, commercial	100 lb.	–	3.25 – 3.60
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 – .17	.17½–
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.36 – .37	.40 – .46
Potassium bitartrate (cream of Tartar)	lb.	.53 – .56	.57 – .58
Potassium bromide, granular	lb.	–	.85 – .90
Potassium carbonate, U. S. P	lb.	–	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.14 – .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.30 – .35
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	.65 – .95
Potassium prussiate, red	lb.	.90 – 1.00	$1.05 –
Potassium prussiate, yellow	lb.	.32 – .36	.38 – .41
Potassium sulphate (powdered)	lb.	$225.00 – 240.00	–
Rochelle salts (see sodium potas. tartrate)	ton	–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake		–	–
Silver cyanide (nominal)	ton	28.00 – 32.00	–
Silver nitrate (nominal)	oz.	–	1.25 –
Soda ash, light	oz.	–	.74 – .76
Soda ash, dense	100 lb.	–	3.50 – 3.60
Sodium acetate	100 lb.	–	3.55 – 3.65
Sodium bicarbonate	lb.	.08½– .09	.09½– .10
Sodium bichromate	100 lb.	2.25 – 2.60	2.75 – 3.00
Sodium bisulphate (nitre cake)	lb.	.39 – .41	.42 – .43
Sodium bisulphite Powered	ton	7.00 – 7.50	8.00 – 10.00
Sodium borate (borax)	lb.	.06 – .06½	.07 – .07½
Sodium carbonate (sal soda)	100 lb.	.09 – .10	.10½–
Sodium chlorate	lb.	1.60 – 1.80	1.80 – 2.00
Sodium cyanide, 96-98 per cent	lb.	–	.12 – .14
Sodium fluoride	lb.	.24 – .25	.26 – .27
Sodium hydroxide (caustic soda)	100 lb.	.18 –	.19 – .20
Sodium hyposulphite	lb.	4.50– 5.50	7.00 – 7.50
Sodium molybdate	lb.	–	.03 – .04
Sodium nitrate	lb.	2.50 –	3.25¾–
Sodium nitrite	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium peroxide, powdered	lb.	.22 – .24	.24 – .25
Sodium phosphate, dibasic	lb.	.32 – .35	.35 – .40
Sodium potassium tartrate (Rochelle salts)	lb.	.03¾– .04½	.04½– .05
Sodium prussiate, yellow	lb.	.39 – .40	.40 – .41
Sodium silicate, solution (40 deg.)	lb.	.23 – .z	.30 – .40
Sodium silicate, solution (60 deg.)	lb.	.01½– .02	.02 – .0½
Sodium sulphate, crystals (Glauber's salt)	cwt.	.02½– .03	.04 – .05
Sodiumsulphide, crystal, 60–62per cent(conc)	lb.	1.50 – 1.70	1.75 – 2.00
Sodium sulphite, crystals	lb.	.09 – .10	.10½– .11
Strontium nitrate, crystals	lb.	.03½–	.04 – .06
Sulphur chloride	lb.	.23 – .24	.25 – .26
Sulphur, crude	lb.	.05¾–	.06 –
Sulphur dioxide, liquid, cylinders	ton	22.00 –	–
Sulphur (sublimed), flour	lb.	.09 –	.10 – .12
Sulphur, roll (brimstone)	100 lb.	3.35 –	3.40 – 3.65
Tin bichloride (stannous)	100 lb.	3.20 –	3.30 – 3.40
Tin oxide	lb.	.42½–	.46 – .50
Zinc carbonate, precipitate	lb.	.60 – .63	.65 –
Zinc chloride, gran	lb.	.16 – .18	.19 – .20
Zinc cyanide	lb.	.13 –	.13½– .15
Zinc dust	lb.	.49 –	.50 – .60
Zinc oxide, U. S. P	lb.	.12½– .12½	.13 – .15
Zinc sulphate	lb.	.18 – .19	.20 – .21
	lb.	.03¼– .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.10 — $1.25
Alpha naphthol, refined	lb.	1.40 — 1.60
Alpha naphthylamine	lb.	.50 — .60
Aniline oil, drums extra	lb.	.34 — .45
Aniline salts	lb.	.46 — .50
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.35 — 1.40
Benzidine, sulphate	lb.	1.20 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.10
Benzoate of soda, U.S.P.	lb.	.80 — 1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .36
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate (nominal)	lb.	.50 — .65
Beta naphthol, sublimed (nominal)	lb.	.70 — .90
Beta naphthol, tech (nominal)	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 — 1.21
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 — 1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.40 — 1.50
Dimethylaniline (nominal)	lb.	– — 1.80
Dinitrobenzol	lb.	.30 — .32
Dinitroclorbenzol	lb.	.30 — .35
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.40 — .45
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.55 — .65
H-acid (nominal)	lb.	2.25 — 2.50
Metaphenylenediamine	lb.	1.15 — 1.85
Monochlorbenzol	lb.	.12 — .15
Monoethylaniline	lb.	1.70 — 1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.15 —
Naphthaline, flake	lb.	.15 — .17
Naphthaline, balls	lb.	.16 — .18
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.20 — .30
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.83 — 1.25
Ortho-nitro-toluol	lb.	.75 — .90
Ortho-toluidine	lb.	.35 — .45
Para-amidophenol, base	lb.	2.50 — 3.50
Para-amidophenol, HCl	lb.	2.50 — 3.25
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.70 — 1.90
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .25
Pyridin	lb.	2.00 — 2.50
Resorcin, technical	gal.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.55 — .65
Salol	lb.	.90 — 1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.25 —	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.24
Sulphanilic acid, crude	lb.	.28 —	.32
Toluidine	lb.	1.70 —	2.50
Toluidine, mixed	lb.	.45 —	.55
Toluol, in tank cars	gal.	.28 —	.....
Toluol, in drums	gal.	.29 —	1.32
Xylidine, drums, 100 gal.	lb.	.44 —	.50
Xylol, pure, in drums	gal.	.37 —	.45
Xylol, pure, in tank cars	gal.	.35 —	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37 —	.45
Xylol, commercial, in tank cars	gal.	.23 —	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36 —	$0.39
Beeswax, refined, light	lb.	.40 —	.41
Beeswax, white pure	lb.	.63 —	.68
Carnauba, No. 1, (nominal)	lb.	.80 —	.88
Carnauba, No. 2, regular (nominal)	lb.	.60 —	.70
Carnauba, No. 3, North Country (nominal)	lb.	.45 —	.46
Japan	lb.	.21 —	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	..... —	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	..... —	.09½
Paraffine waxes, refined, 118-120 m.p.	lb.	..... —	.11½
Paraffine waxes, refined, 128-130 m.p.	lb.	..... —	.13½
Paraffine waxes, refined, 133-135 m.p.	lb.	.14 —	.15
Paraffine waxes, refined, 135-137 m.p.	lb.	.16 —	.16½
Stearic acid, single pressed	lb.	.26 —	.27
Stearic acid, double pressed	lb.	.32 —	.29
Stearic acid, triple pressed	lb.	.32 —	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.946	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

*Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$16.95	—$18.75
Rosin E-I	280 lb.	18.75	— 19.00
Rosin K-N	280 lb.	19.00	— 21.00
Rosin W. G.-W. W.	280 lb.	20.50	— 21.50
Wood rosin, bbl.	280 lb.	15.50	— 18.50
Spirits of turpentine	gal.	.....	— 2.50
Wood turpentine, steam dist.	gal.	2.35	— 2.40
Wood turpentine, dest. dist.	gal.	.....	— 2.00
Pine tar pitch, bbl.	200 lb.	8.40	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	— 15.00
Retort tar, bbl.	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.92	— .95
Rosin oil, second run	gal.	.94	— .97
Rosin oil, third run	gal.	1.00	— 1.05
Rosin oil, fourth run	gal.	1.10	— 1.15

* (See New York market letter)

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½ —	$0.42
Upriver coarse	lb.	.29 —	.32
Upriver caucho ball	lb.	.30½ —	.33
Plantation—First latex crepe	lb.	.44 —	.45
Ribbed smoked sheets	lb.	.44½ —	.....
Brown crepe, thin, clean	lb.	.42 —	.....
Amber crepe No. 1	lb.	.40½ —	.41½

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½ —	$0.20
Castor oil, AA, in bbls.	lb.	.20 —	.23
China wood oil, in bbls.	lb.	.24 —	.24½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½ —	.19½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.20 —	.21
Corn oil, crude, in bbls.	lb.	.17½ —	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15¼ —	.16
Cottonseed oil, summer yellow	lb.	.18½ —	.19
Cottonseed oil, winter yellow	lb.	.21 —	.23
Linseed oil, raw, car lots	gal.	1.72 —	.....
Linseed oil, raw, tank cars	gal.	1.67 —	.....
Linseed oil, boiled, car lots	gal.	1.75 —	.....
Olive oil, commercial	gal.	2.75 —	3.00
Palm, Lagos	lb.	.15½ —	.16½
Palm, bright red	lb.	.14½ —	.17½
Palm, Niger	lb.	.14 —	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.22 —	.23
Peanut oil, refined, in bbls.	lb.	.23 —	.26
Rapeseed oil, refined in bbls.	gal.	1.62 —	1.64
Rapeseed oil, blown, in bbls.	gal.	1.68 —	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17 —	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14 —	.14½

FISH

Winter pressed Menhaden	gal.	$1.17 —	$1.18
Yellow bleached Menhaden	gal.	1.20 —	1.22
White bleached Menhaden	gal.	1.23 —	1.24
Blown Menhaden	gal.	1.34 —	1.36

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—$40.00
Barytes, off color	ton	20.00 —	25.00
Barytes, crude	ton	10.00 —	12.00
Blanc fixe, dry	lb.	.05½ —	.06½
Blanc fixe, pulp	ton	60.00 —	80.00
Casein	lb.	.15 —	.18
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.04½ —	.06
Chalk, English, dense	lb.	.04 —	.05
China clay (Kaolin), imported, lump	ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	ton	30.00 —	60.00
China clay (Kaolin), domestic, lump	ton	10.00 —	20.00
China clay (Kaolin), domestic, powdered	ton	25.00 —	40.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50 —	18.00
Fuller's earth, domestic, powdered	ton	25.00 —	30.00
Fuller's earth, imported, powdered	ton	35.00 —	40.00
Graphite, crucible, 85% carbon content	lb.	..... —	.07½
Graphite, crucible, 86% carbon content	lb.	..... —	.08
Graphite, crucible, 87% carbon content	lb.	..... —	.08½
Graphite, crucible, 88% carbon content	lb.	..... —	.09
Graphite, crucible, 89% carbon content	lb.	..... —	.09½
Graphite, crucible, 90% carbon content	lb.	..... —	.10
Graphite, crucible, 91% carbon content	lb.	..... —	.10½
Graphite, crucible, 92% carbon content	lb.	..... —	.11
Graphite, crucible, plus 92%	lb.	..... —	.12½
Pumice stone, imported	lb.	.03 —	.06
Pumice stone, domestic	lb.	.02½ —	.....
Shellac, orange, fine	nominal lb.	1.50 —	.....
Shellac, orange, superfine	lb.	1.60 —	1.65
Shellac, A. C. garnet	lb.	1.30 —	1.35
Soapstone	ton	15.00 —	25.00
Talc, domestic	ton	20.00 —	30.00
Talc, imported	ton	60.00 —	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton $75-80 at Chester, Penn.
Chrome cement	net ton 45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000 45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000 40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton 50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton 80-85 at Chester, Penn.
Silica brick	1,000 50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20 —	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21 —	.22
Ferro-manganese, 70-80% Mn.	gross ton	200.00 —	250.00
Spiegeleisen, 16-20% Mn.	gross ton	73.00 —	75.00
Ferro-molybdenum, per lb. of Mo.	lb.	2.25 —	2.75
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	200.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90 —	1.10
Ferro-uranium, 35-50% of U	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	$0.70 —	$0.85
Chrome ore, 48% and over	† unit	..... —	.....
Coke, foundry, f.o.b. ovens	net ton	12.00 —	14.00
Coke, furnace, f.o.b. ovens	net ton	11.00 —	12.00
Petroleum coke, refinery, Atlantic seaboard	net ton	..... —	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00 —	30.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00 —	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00 —	65.00
Manganese ore, 45% Mn and over	unit	.80 —	.95
Manganese ore, chemical (MnO_2)	gross ton	80.00 —	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 —	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 —	7.50
Uranium oxide, 96%	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore	lb.	1.00 —	3.00
Pyrites, foreign, lump	unit	.17 —	.....
Pyrites, foreign, fine	unit	.17 —	.....
Pyrites, domestic, fine	unit	.16 —	.17½
Ilmenite, 52% TiO_2	lb.	.02 —	.....
Rutile, 95% TiO_2	lb.	.11 —	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 —	3.00
Zircon, washed, iron free	lb.	.10 —	.....
Monazite, per unit of ThO_2	unit	42.00 —	.....

*Nominal †See New York Market Letter

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45@	$4.00
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45@	4.00
Tees, 3-in. and larger	100 lb.	2.45@	4.00
Plates	100 lb.	2.65@	4.00
Rivets, structural, ¾-in. and larger	100 lb.	4.50	
Rivets, conchead for boilers, ¾-in. and larger	100 lb.	4.60	
Sheets, No. 28 black	100 lb.	4.35@	6.50
Sheets, No. 10 blue annealed	100 lb.	3.55@	6.00
Sheets, No. 28 galvanized	100 lb.	5.70@	8.50

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

WESTEND (San Rafael P. O.)—The Westend Mining Co. has awarded the contract for the construction of a borax plant, to John Simpson Co., Grant Bldg., Los Angeles. Estimated cost, $50,000.

Connecticut

BRIDGEPORT—The city voted $550,000 bonds to construct a sewage disposal plant, etc., in the eastern section of the city.

MERIDEN—E. Miller & Co., 99 Center St., is having plans prepared for the construction of a 5-story factory on Center St., for the manufacture of lamps. Estimated cost, $100,000. Orr & Dell Grella, 956 Chapel St., New Haven, archts.

MIDDLETOWN—Wilcox, Crittendon & Co., Inc., 8 South Main St., plans to build a 1-story foundry. Estimated cost, $50,000.

WINDSOR—The Merwin Paper Co., Rainbow St., will build a 2-story, 42x125-ft. factory. Estimated cost, $30,000. Work will be done by day labor.

Delaware

WILMINGTON—A. R. Harrigan, 819 Van Buren St., is in the market for material handling equipment and machines for making concrete drain tile, hollow blocks and concrete bricks.

Illinois

CHICAGO—The Flexible Steel Lacing Co., 522 South Clinton St., has awarded the contract for the construction of a 1- and 2-story, 125x260-ft. factory at 4619 Lexington St., to J. C. Carnegie & Son, 189 West Washington St. Estimated cost, $200,000. Noted Feb. 18.

CHICAGO—The E. F. Kiefer Tanning Co., 416 West Lake St., plans to build a 3-story, 100x200-ft. tannery on Kingsbury St. and Wabansia Ave. Estimated cost, $150,000.

KEWANEE—The city plans to install intercepting sewers, tanks and sprinkling filters. Estimated cost, $250,000. Alvord & Burdick, 8 South Dearborn St., Chicago, archts.

STERLING—The Fort Dearborn Mfg. Co. has awarded the contract for the construction of a 100x120-ft. foundry, here, to H. D. Moreland & Co., 3701 Sheffield Ave., Chicago. Estimated cost, $50,000.

Iowa

COUNCIL BLUFFS—The Bd. Educ. will soon award the contract for the construction of a 2-story, 75x135-ft. school. A chemical laboratory will be installed in same. Estimated cost, $300,000.

GLIDDEN—The Bd. Educ. received bids for the construction of a 3-story, 90x162-ft. school from W. F. Kucharo & Co., 622 Hubbell Bldg., Des Moines, $170,654; the Western Constr. Co., Earlham, $173,000; Garmer & Stiles, 422 Flynn Bldg., Des Moines, $173,989. A chemical laboratory will be installed in same.

HUMESTON—The city will receive bids until May 18 for the construction of a sewage disposal plant, etc. M. G. Hall, engr.

Massachusetts

DANVERS—The School Bd. plans to construct a 3-story high school here. A chemical laboratory will be installed in same. Estimated cost, $350,000.

SPRINGFIELD—H. L. Sprague, archt., 310 Main St., will soon award the contract for the construction of a 1-story, 60x130-ft. manufacturing plant addition, for the Natl. Papeterie Co., Orleans St. Estimated cost, $40,000.

Michigan

MT. CLEMENS—S. S. Kresge Co., Kresge Bldg., Detroit, has awarded the contract for the construction of a 1-story, 120x823-ft. pottery plant, including kiln room, to G. A. Fuller Co., 540 Penobscot Bldg., Detroit.

Minnesota

BUHL—The Bd. Educ. has awarded the contract for the construction of a 3-story, 148x245-ft. addition to the high school, to the Natl. Constr. Co., Virginia, at $208,714. A chemical laboratory will be installed in same.

HERMAN—The Bd. Educ. will soon award the contract for the construction of a 2-story, 94x130-ft. school. A chemical laboratory will be installed in same. Estimated cost, $125,000. A. H. Morken, ch. L. F. Broomhall, 410 Alworth Bldg., Duluth, archt. and engr.

HIBBING—The Bd. Educ. has awarded the contract for the construction of a 3-story, 174x417-ft. addition to the high school on 3rd St., to Jacobson Bros., Columbia Bldg., Duluth, at $549,500. A chemical laboratory will be installed in same.

Missouri

KANSAS CITY—The Sinclair Refining Co., 111 West Washington Ave., Chicago, has awarded the contract for the construction of a 1-story, 14x36-ft. filling station, to the Weimmer Constr. Co., Ry. Exch. Bldg. Estimated cost, $9,000.

New Jersey

CAMDEN—George D. Wetherill & Co., Haddon Ave. and White Horse Pike, has awarded the contract for the construction of varnish kilns, to J. S. Rogers, Drexel Bldg., Philadelphia, Pa. Estimated cost over $10,000.

NEWARK—The United Color & Pigment Co., Evergreen and McClellan Sts., has awarded the contract for the construction of a 1- and 2-story paint factory, to Joseph Jewks & Sons, 676 Montgomery St., Jersey City. The company will be in the market for chemicals to be used in the manufacture of paint.

PLEASANTVILLE—The City Council has awarded the contract for the construction of a screening and pumping station buildings, to Seaman, Letzkus & Smith, at $42,914; for the installation of mechanical equipment, cost, $32,361 and force mains, cost, $21,890, to Simpson & Brown Co., 90 West St., New York City. Noted April 7.

New York

BUFFALO—The Standard Oil Co., Elk and Babcock Sts., has awarded the contract for the construction of several additions to the Atlas Plant here, to John W. Cowper Co., Inc., Fidelity Bldg.

LONG ISLAND CITY—The Elcaya Co., Inc., 148 Madison Ave., New York City, is building a 4-story, 100x100-ft. factory and laboratory on 1st St. and Freeman Ave. Estimated cost, $75,000. J. Baker, 6 Jackson Ave., archt. and engr. Noted May 12.

LONG ISLAND CITY—The Nichols Copper Co. has filed plans for the construction of a 1-story building here. Estimated cost, $20,000.

North Carolina

LEXINGTON—The Bd. Comrs. plans to build a 2-story, 77x209-ft. high school here. A chemical laboratory will be installed in same. Estimated cost, $80,000. J. H. Cowles, supt.

ST. PAUL—The town will receive bids until May 20 for the construction of sewers, including a sewage disposal plant, etc. J. C. Lenthe, mayor.

Ohio

CINCINNATI—The Hercules Rubber Corp., 908 Union Central Bldg., plans to construct a 2- or 3-story, 200x300-ft. factory for the manufacture of auto tires. Estimated cost, $500,000. W. G. Brown, 2301 Union Central Bldg., engr.

CLEVELAND—The city received bid for the construction of a filtration plant at Baldwin, from R. E. Carey Co., West 112th St., $369,600. Noted May 12.

CLEVELAND—The Gebauer Chemical Co., 9408 St. Catherine Ave., has awarded the contract for the construction of a 1-story, 40x100-ft. factory addition, to the William Dunbar Co., 8201 Cedar Ave. Estimated cost, $25,000.

CLEVELAND—The Interstate Foundry Co., 3161 East 61st St., has awarded the contract for the construction of a 1-story, 80x160-ft. sand and core building, to the A. A. Lane Constr. Co., 1836 Euclid Ave. Estimated cost, $100,000.

LAKEWOOD (Cleveland P. O.)—The Bd. Educ. plans to build a junior high school on Jackson Ave. A chemical laboratory will be installed in same.

MASSILLON—The Massillon China Co., Inc., plans to construct a 1- and 2-story, 100x200-ft. pottery manufacturing plant along the Baltimore & Ohio R.R. tracks north of West Main St. The plant will consist of 13 kilns, etc. Estimated cost, $300,000.

Pennsylvania

HOLMESBURG (Philadelphia P. O.)—The Robertson Lubricants Co., Bulletin Bldg., has awarded the contract for the construction of a 1-story, 26x60-ft. factory here, to Barclay, White & Co., 1713 Sansom St. The company will be in the market for chemicals which will be used for the manufacture of lubricants. Estimated cost, $10,000.

Texas

DALLAS—The Bd. Educ. will receive bids until May 29 for the construction of a 3-story high school on Haskell and McKinney Sts. A chemical laboratory will be installed in same. Estimated cost, $300,000. C. M. Moore, secy. W. B. Ittner, 911 Locust St., St. Louis, Mo., archt.

TEXARKANA — The Southern Steel Products Co., 520 Spring St., will build a refinery. Estimated cost, $60,000. Work will be done by day labor.

West Virginia

CLARKSBURG—The Phelps Can Co., Lawrence St., Baltimore, plans to build a 1- and 2-story plant on a 4½-acre site here, for the manufacture of cans, to include an 85-ft. main building and 6 adjoining buildings. Estimated cost, $100,000.

Wisconsin

MILWAUKEE—H. A. Poppert, 504 Cedar St., is in the market for brass foundry supplies.

SHEBOYGAN — The Amer. Hide & Leather Co., 1102 Wisconsin Ave., is having preliminary plans prepared for the construction of a 2-story, 50x130-ft. addition to its tannery on Wisconsin Ave. Estimated cost, $50,000. F. Schnellen, mgr. Juul & Smith, Imig Bldg., archts.

Cuba

CIENFUEGOS—The city will receive bids about June 1 for the construction of a mechanical filtration plant to have a 17,000,000-gal. capacity. Estimated cost, $150,000. A. Potter, 50 Church St., New York City, engr.

Ontario

GALT—The Galt Brass Co. will build two 1-story additions to its present plant here. Estimated cost, $50,000.

GUELPH—T. Eaton Co., Ltd., 190 Yonge St., Toronto, plans to build an office building and an addition to its stove foundry and factory here. Estimated cost, $115,000. H. McGee, supt. W. A. Mahoney, 73 Quebec W., archt.

LONDON—C. H. Hyman & Co., Richmond St., is building a leach house in connection with its tannery on Richmond St. and will be in the market for leaching equipment. Estimated cost, $25,000. H. A. McBride, Molsons Bank Bldg., archt.

OTTAWA—The city, c/o Stevens & Lee, archts., 2, College St., Toronto, will soon receive bids for the construction of a hospital to include an X-ray equipment. Estimated cost, $2,500,000.

TORONTO—The Hobbs Mfg. Co., 279 King St., W., has awarded the contract for converting a building into a plate glass factory, to William T. Sparling & Co., 120 Bay St. Estimated cost, $30,000.

TORONTO—The United Drug Co., Ltd., 78 Broadview Ave., has awarded the contract for the construction of a drug factory addition on Broadview Ave., to L. E. Dowling, 167 Yonge St. Estimated cost, $130,000.

SARNIA—The Holmes Fdry. Co. has awarded the contract for the construction of a foundry building, to Wells & Gray, Confederation Life Bldg., Toronto. Estimated cost, $100,000.

SAULT STE. MARIE—The Algoma Steel Corp. has awarded the contract for furnishing finishing mills with hot beds and tables in connection with the $7,000,000 steel plant extension here, to the Morgan Eng. Co., Alliance, O.

Quebec

MESOPOTAMIA—The Shell Transport & Trading Co. plans to construct buildings and tanks and install equipment in connection with the proposed development of the oil fields here.

Coming Meetings and Events

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold a regular meeting June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS will meet in St. Louis May 27 to 29.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18, inclusive.

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK announces the following lecture in the Doremus Lecture Theater: Friday, May 14, at 4 p.m., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern.*)

THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA plans to hold its annual convention in the Auditorium Theater, Chicago, Ill., May 19, 20 and 21.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE NEW JERSEY CHEMICAL SOCIETY will hold a regular meeting and ladies' day Saturday afternoon and evening June 5, at Rutgers College, New Brunswick, N. J.

THE SOCIÉTÉ CHIMIE INDUSTRIELLE will hold a meeting at the Chemists' Club, May 14.

THE SOCIETY OF CHEMICAL INDUSTRY, American Section, will hold a meeting, May 21, at the Chemists' Club.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

Industrial Notes

THE CARBORUNDUM CO. of Niagara Falls, N. Y., is to spend approximately half a million dollars in extending and improving its plant at Niagara Falls and its two big furnace plants, one at Niagara Falls, Ont., and the other at Shawinigan Falls, Que. The plan includes a 3-story addition to the paper and cloth plant at Niagara Falls in which are manufactured carborundum paper and cloth, carborundum garnet paper and cloth and aloxite cloth. This addition, which has just been finished, is 432 ft. long and 81 ft. wide and will provide greater facilities for the storing and curing of all paper and cloth products, and for the extension of the rubber-bonded wheel department. Another addition, just completed, will extend one of the wheel-making and kiln departments, the new building being two stories high, 96 ft. long and 64 ft. wide. Both of these new structures are of concrete and are of the most modern type. Other big extensions and improvements have been planned and work will be started immediately. These plans call for additions to the crushing departments and other improvements at the furnace plant at Niagara Falls, Ont., where the abrasive aloxite is made and at Shawinigan Falls, Que., where is located an extensive carborundum furnace plant.

THE LAKEWOOD ENGINEERING CO., Cleveland, Ohio, awarded the first prize of $1,000 for the best treatise on industrial haulage using Lakewood Tier-Lift trucks to Clarence Irving McNair, Jr., of Cloquet, Minn. Mr. McNair, who is secretary of the Northwest Paper Co. of Cloquet, won the prize with a paper entitled "Analysis of the Application of the Tier-Lift Truck to the Pulp and Paper Industry." The treatise indicates the possibilities of considerable savings in the handling of ground wood pulp by Tier-Lift to and from storage either with or without a steam house process. The arrangement suggested by Mr. McNair would effect a reduction of wood pulp losses due to deterioration from the growth of fungi or to disintegration from over-long storage. Second prize was awarded to F. C. Peters, chief mechanical engineer, and G. R. Reese, assistant mechanical engineer, New Jersey Zinc Co., Palmerton, Pa. This treatise, which deals with the handling of zinc oxide in barrels and bags, contains valuable data for the movement of bag or barrel packages. Theodore M. Prudden of the Whitin Machine Works, Whitinsville, Mass., was awarded third prize for an analysis entitled "The Tier-Lift Truck—Its Field of Usefulness." F. L. Usner, with L. V. Estes, Inc., of Chicago, received honorable mention. Mr. Usner's paper, "The Tier-Lift Method Applied to the Paper Industry," is an excellent supplement to Mr. McNair's treatise. It deals with the handling of baled rags and paper-making stock and contains valuable suggestions for the handling of finished rolls of paper. A splendid paper by Frederick L. Fish, industrial engineer with the Fisk Rubber Co., Chicopee Falls, Mass., was also given honorable mention. This treatise, "Application of Tier-Lift Truck to Stores Problem of Handling Materials," while it deals more specifically with the rubber industry, contains valuable suggestions for the general handling of stores. The award committee, consisting of A. Russell Bond of the *Scientific American Monthly*, Prof. Dexter S. Kimball, dean of the School of Engineering, Cornell University, and Irving A. Berndt, vice-president of C. E. Knoeppel, pronounced the standard of papers submitted unusually high and declared that the data received will add materially to present-day knowledge of factory haulage.

THE DRYING SYSTEM, INC., has recently moved its offices and factory to 11-17 South Desplaines St., Chicago, Ill. The increased floor space secured will allow an added production of varnish drying equipment.

THE ROHDE LABORATORY SUPPLY CO. has been incorporated under the laws of New York, and will be located at 17 Madison Ave., New York City, for the export and import of apparatus and instruments for all branches of science, chemicals and reagents.

THE INTERNATIONAL TIME RECORDING CO., of Endicott, N. Y., has established a distributing agency in Memphis, Tenn., with W. M. Richards in charge of the district.

THE WEATHERCROFT CO., of Cleveland, Ohio, has established branch offices in the Randolph Building, Memphis, Tenn. This branch will be in charge of F. H. Ford and will distribute roofing liquid and plastic cement.

THE CHINCA CHEMICAL CO., INC., has recently erected a plant at 344 Poplar Ave., Memphis, Tenn., for the manufacture of extracts, medicines and non-alcoholic beverages.

THE MOLINE-HOOPER CO. has been organized, with headquarters at Memphis, Tenn., to take over the Gale-Hooper Co., effective June 1, 1920. The officials of the new company are also officials of the Moline Plow Co. The new organization will engage in the manufacture of farm implements in general, as well as tractors and automobile trucks.

THE SQUARE D COMPANY, Detroit, Mich., announces that D. H. Colcord has been appointed advertising manager. Prior to this change he served in the capacity of director of research engineering, which position has been taken over by L. W. Strong, formerly of the publicity department of the Westinghouse Air Brake Co.

M. S. ORTH, president and director of Marden, Orth and Hastings Co., has severed his official connection with that company and will devote his time to other interests. Mr. Orth, who is one of the largest stockholders, retains his interests in the company.

THE COMBUSTION ENGINEERING CORPORATION, with offices at 11 Broadway, New York City, announces with regret the resignation of E. P. Moritz, its vice-president, in charge of sales. Mr. Moritz had been ill for some time previous to his resignation and owing to his continued ill health it has been necessary for him to retire from active business for some time. No successor to Mr. Moritz has been named by the company.

Manufacturers' Catalogs

THE CHARLESTON INDUSTRIAL CORP., which is operating the City of Nitro, W. Va., has issued a booklet entitled "Public Utilities, City of Nitro, W. Va." A technical description is given of the various public utilities which have been and are now in constant operation. Descriptions are also given of the boiler plant, power plant, steam and air distribution system and electrical system, fire alarm system, gas distribution system, water system, sewer system, railway system, together with maps and illustrations.

THE JEFFREY MANUFACTURING CO., Columbus, Ohio, announces a new publication, which is catalog No. 259, entitled "Jeffrey Shredders, Type E." Illustrations and descriptions are given of this Type E swing hammer shredder (ball-bearing) which is used for reducing wood chips, bark and other fibrous materials. Particular attention is called to the simplicity of design, provision made for capacity, for durability and accessibility of working parts, and its adaptability to the handling of a variety of materials under different conditions of installation and operation. Illustrations are also given of installations, together with plant layouts, engineering information and other data of service to plant manager and superintendent.

THE UNDER-FEED STOKER CO. OF AMERICA, Detroit, Mich., has just received from the press two catalogs, one on the "Design and Operation of Heating Furnaces," by Nelson G. Phelps, and the other "Industrial Heating Furnaces Equipped With Jones Under-Feed Mechanical Stokers." Many interesting photographs are given of actual installations, together with descriptive matter.

THE GRISCOM-RUSSELL CO., New York City, is distributing a small folder, Leaflet No. 6, which briefly describes all of the apparatus manufactured by this company and which is designed to be a ready reference. Bulletin No. 1,140 illustrates and describes the Stratton steam separator.